SOCIALIST REPUBLIC OF VIETNAM
CAN THO PEOPLE'S COMMITTEE
CAN THO WATER SUPPLY AND SEWERAGE COMPANY, LTD.

PREPARATORY STUDY ON CAN THO CITY WATER SUPPLY IMPROVEMENT PROJECT

FINAL REPORT (MAIN REPORT)

March 2013

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NIPPON KOEI CO., LTD.
SWING CORPORATION
MITSUBISHI CORPORATION
PRICEWATERHOUSECOOPERS CO.,LTD.

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Exchange Rate

1 USD = 77.92 USD

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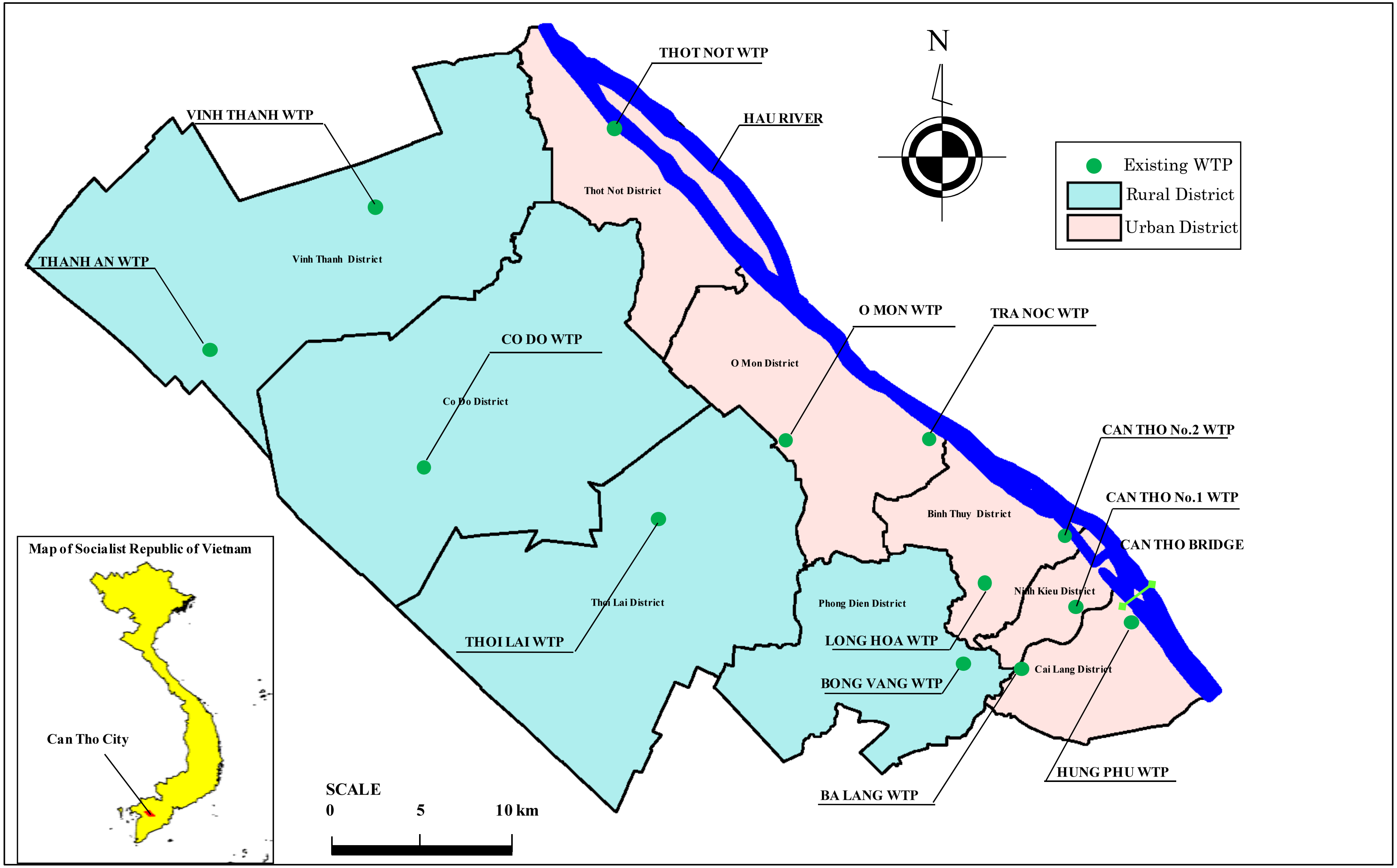
(As of End of May 2012)



Source : JICA Study Team

Location Map of Study Area

PREPARATORY STUDY ON CAN THO CITY WATER SUPPLY IMPROVEMENT PROJECT

FINAL REPORT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AC	Accelator
AF	Aquazur Filter
AMSL	Above Mean Sea Level
ARP	Abbreviated Resettlement Plan
BOD	Biological Oxygen Demand
BOT	Build Operate Transfer
BTO	Build Transfer Operate
C/B	Cost-Benefit Ratio
Can Tho PC	the People's Committee of Cantho City
CAPEX	Capital Cost
CERWAS	Center for Rural Water Supply and Sanitation
CGF	Conventional Gravity Filter
CIF	Cost, Insurance and Freight
COD	Chemical Oxygen Demand
DARD	Department of Agriculture and Rural Development Can Tho City
DCI	Ductile Cast Iron
DF/R	Draft Final Report
DI	Ductile cast Iron
DO	Dissolved Oxygen
DOC	Department of Construction of Cantho City
DOF	Department of Finance of Can Tho City
DONRE	Department of Natural Resources and Environment of Cantho City
DOST	Department of Science and Technology of Can Tho City
DOT	Department of Transportation
DP	Displaced Person
DPI	Department of Planning and Investment of Cantho City-Vietnam
DSRA	Debt Service Reserve Account
EIA	Environmental Impact Assessment
EIRR	Equity Internal rate of Return
EPC	Engineering, Procurement and Construction
EVN	Vietnam Electric Corporation
F/R	Final Report
F/S	Feasibility Study
GDP	Gross Domestic Product
GLF	Green Leaf Filter
GSO	General Statistics Office
HM	Hydraulic Mixing
IC/R	Inception Report
IMF	International Monetary Fund
IRR	Internal Rate of Return
IZ	Industrial Zone

JICA	Japan International Cooperation Agency
LPEB	Land Pricing Evaluation Board
MM	Mechanical Mixing
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
NPV	Net Present Value
NRW	Non-Revenue Water
ODA	Official Development Assistance
O&M	Operation and Maintenance
OPEX	Operation and Maintenance Cost
PACl	Poly Aluminum Chloride
PF	Pressurized Filter
PPP	Public Private Partnership
PSIF	Private Sector Investment Fund
PU	Pulsator
PVC	Polyvinyl Chloride
RAP	Resettlement Action Plan
RRA	Replacement Reserve Account
SB	Sludge Blanket
SCF	Standard Conversion Factor
SEPIZA	Can Tho Export Processing & Industrial Zones Authority
SIWRPM	Sub-Institute of Water Resources Planning and Management
SPC	Special Purpose Company
SS	Suspended Solid
TOR	Terms of Reference
TSS	Total Suspended Solids
VAT	Value Added Tax
VND	Viet Nam Dong
VVVF	Variable Voltage Variable Frequency
WLG	Water Level Gauge
WSSC	Cantho Water Supply and Sewerage Company., Ltd
WTP	Water Treatment Plant

CHAPTER 1 INTRODUCTION

1.1 Background

Can Tho City on the right bank of Hau River, the largest tributary of the Mekong River, is located at about 120 km southwest of Ho Chi Minh City. In 2004, the Can Tho Province was divided into Can Tho City and Hau Giang Province under the decision of the national government. Can Tho City was designated as a centrally governed city. Can Tho City has an area of approximately 1390 km^2 and a population of 1.2 million as of 2011. The population is projected to increase up to 1.5 million in 2020.

Currently, Can Tho City has become one of the most important hubs for economy, culture, and science in the Mekong Delta area. However, due to the rapid increase in population and economic growth, water scarcity has become a critical condition. Groundwater contamination in the surrounding area of Can Tho City and salt water intrusion from the downstream of Hau River have are among the critical issues on the water environment. To cope with these problems, groundwater extraction has been strictly restricted in recent years. New intake facilities for water supply have been recommended to be constructed in the upstream area to avoid salt water intrusion and water contamination.

Under such condition, the Can Tho People's Committee (hereinafter referred to as Can Tho PC) has proposed in its general master plan to establish new intake and water treatment facilities in the upstream area of Hau River as well as transmission and distribution mains to meet the water demand in Can Tho City for the target year of 2030. In addition, the Can Tho PC planned to execute the water supply system improvement jointly with private sector participation.

To meet the abovementioned requirement of Can Tho PC, the Japan International Cooperation Agency (JICA) has decided to execute a technical assistance in carrying out the preparatory study, namely, the Feasibility Study for Private Sector Participation in the Water Supply Project for the target year 2020 (hereinafter referred to as the “Study”). The Study will help in clarifying the necessity and sustainability of the project in view of its technical, financial, and environmental aspects as well as proposing optimum implementation plan and operation and management (O&M) schemes by utilizing private investment and foreign funds.

The Study was commenced in the beginning of May 2012 and continues for about 10 months until the end of February 2013 performing field works and home works in five stages. The major findings and analytical results carried out during the course were summarized in this Report.

1.2 Objective and Necessity of the Preparatory Study

In recent years, the ODA debt against GDP in Vietnam has increased and subsequently the Government of Vietnam has decided to expand the project promotion utilizing public-private partnership (PPP) schemes. Pursuant to this decision, the Can Tho PC has decided to execute the water supply and sewerage projects under PPP schemes in 2012. As of date, however, practical projects have not been executed in Can Tho City.

Under such conditions, Nippon Koei Co., Ltd., Mitsubishi Corporation, and Swing Corporation proposed to implement water supply system improvement projects by establishing a special purpose company (SPC). These will be under the financial support of JICA's Private Sector Investment Fund (PSIF), together with the implementation of this Study through grant aid.

1.3 The Study Area

The Study area covers Can Tho City consisting of urban and rural districts. For the selection of priority projects to be carried out under JICA's PSIF scheme, practically through build-operate-transfer (BOT) scheme, the core area of the city center was selected as the priority project area.

CHAPTER 2 GENERAL CONDITIONS OF THE PROJECT AREA

2.1 Natural Conditions

2.1.1 Topography

The total area of Can Tho City is 298,561 ha, and the land is covered by fertile alluvial soil, which is suitable for agriculture. According to the 2010 report on the existing environmental conditions in Can Tho City, about 82% of the land is used for agriculture, 17% is used for non-agricultural such like residential area and industrial zones, and 1% is not used.

The general topography of Can Tho City is relatively flat, and which is gradually low from north to south and from east to west (from Hau River to the inner land). Can Tho City has an altitude of 0.2-1.5 m, and slightly declines from the Hau River bank to the inner land. The altitude of the Hau River bank is approximately 1.0-1.5 m, while the inner land is approximately 0.5-1.0 m. The altitude of Can Tho City is shown in Figure A1.1 in Appendix A1.

There are 158 tributaries and canals that intersect within the city. The total length of the rivers and canals in Can Tho City is 800 km. The largest river in the city is the Hau River. Besides, there is also Can Tho River and seven main channels: Dau Sau, Cai Son, Rau Ram, Truong Tien, Cai Doi, Cai Da, and Cai Nai.

According to the 2010 Report on the existing environmental conditions in Can Tho City, the northern part of the city is flooded annually at Thot Not District, Vinh Thanh District, some parts of Co Do District, and some parts of O'Mon District.

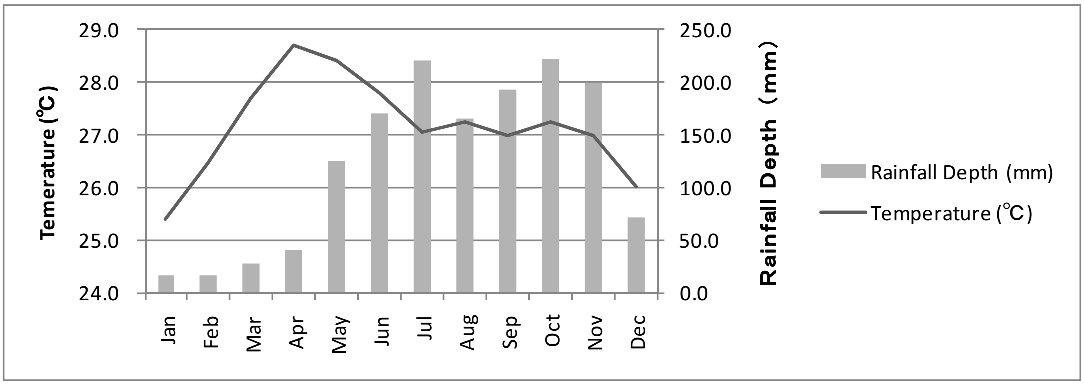
There are three main navigation routes in Can Tho City: theCan Tho River-Xa No Canal route to Ca Mau; O Mon River-Thi Doi Canal route to Cai Be River; and Cai San Canal-Rach Soi Canal route to Kien Luong.

2.1.2 Meteorology

(1) Temperature

Can Tho City is located in a tropical and monsoonal region. It is hot and humid all year round.

The annual mean temperature is around 27 °C. The monthly mean temperature together with rainfall depth of Can Tho City from 2005 to 2011 is shown in Figure 2.1.1.



Source: Statistical Yearbook of Can Tho City 2011

Figure 2.1.1 Mean Monthly Temperature and Rainfall Depth of Can Tho City

(2) Rainfall

Annual rainfall of Can Tho City varies from 1200 mm to1700 mm. The mean annual rainfall is 1500 mm.

The rainy season lasts from May to November, while the dry season is from December to April. The total rainfall depth in rainy season accounts for more than 90% of the annual rainfall. Long and heavy rain commonly comes once or twice a month with a rainfall of 50-100 mm. The mean monthly rainfall of Can Tho City from 2005 to 2011 is shown in Figure 2.1.1.

During peak hours, heavy rain combined with high tide of the Hau River overflows and inundates the city, leading to traffic jam in the city area. This case happens especially on National Road No. 91 from Binh Thuy District to O'Mon District according to the 2010 report on the existing environmental conditions in Can Tho City.

(3) Sunshine Hours, Humidity, and Wind

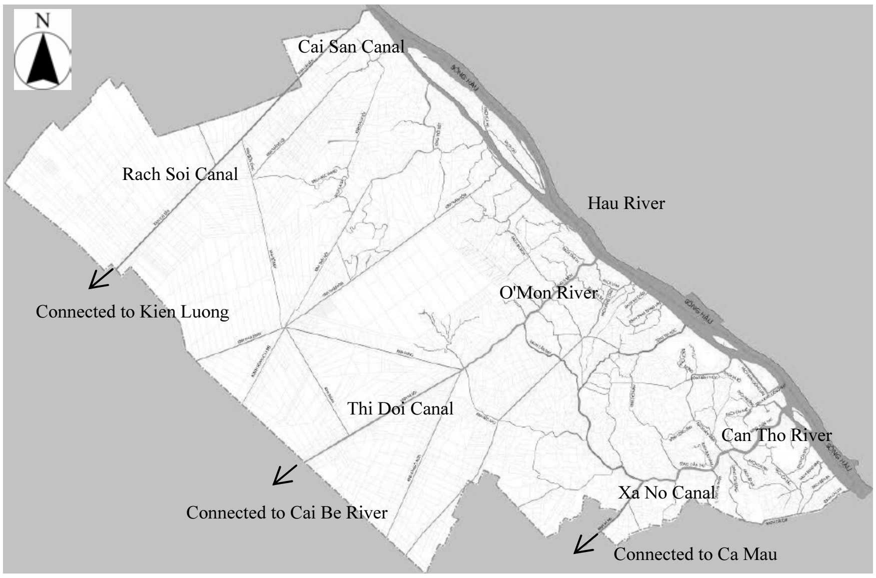
The mean annual sunshine hour is 2249.2 hr according to the Can Tho City General Master Plan 2030 and the mean annual humidity is 82%.

The wind characteristics are different in the wet and dry seasons. According to the 2010 report on the existing environmental conditions in Can Tho City, the winds during the dry season follow the direction of the northeast wind with an average velocity of 3.0 m/s, while that during the wet season is the southwest wind with an average velocity of 1.8 m/s.

2.1.3 Hydrology

(1) River and Canal System of Can Tho City

There are numerous tributaries and canals that intersect within the city. According to the Can Tho City Master Plan 2030, the total length of the rivers and canals in Can Tho City is 800 km. The largest river is the Hau River that runs to the northeast of the city. It is one of the largest rivers is the Can Tho River originating from the inner land of the city, and meets with the Hau River in the eastern side of the city. There are 158 rivers and canals in the city that form the waterway network. The water of inner canals is contaminated with wastes from residential areas, production factories, and so on. There are three main navigation routes in the city: Can Tho River – Xa No Canal route to Ca Mau; O'Mon River – Thi Doi Canal route to Cai Be River; and Cai San Canal – Rach Soi Canal route to Kien Luong. The river and canal network of Can Tho City is shown in Figure 2.1.2.



Source: Can Tho City General Master Plan 2030

Figure 2.1.2 River and Canal Network of Can Tho City

In Can Tho City, there is a water level gauging station that records the level of the Hau River. The water level at the Can Tho Station is affected by tide level. The location map of the hydrological and meteorological monitoring network in South Vietnam is shown in Appendix A1 Figure A1.7. Water level gauging station (WLGs) in the Hau and Tien Rivers, which have long-term water level and discharge data and not affected by tide, are only Tan Chau and Chau Doc Stations. Both stations are located close to the Cambodia-Vietnam border.

(2) Characteristics of the Hau River

In Cambodia, the Mekong River is separated into two branches: the Bassac River and the Mekong River. The Mekong River further branches into two which flow into Vietnam, namely, the Hau River and the Tien River. After entering Vietnam, the Tien River is separated into two branches: the Tien River and the Vam Nao River . The length of the Vam Nao River is only 6 km, and it flows into the Hau River. The Hau River flows to the South China Sea via two river mouths: Tran De and Dinh An. The Tien River flows to the sea via six river mouths: Cung Hau, Co Chien, Ham Luong, Ba Lai, Dai, and Tieu. The longitudinal profile of the Hau River is also flat, as shown in Appendix A1 Figure A1.6.

Generally the flow ratio of the Hau River is about 200 billion m^3 per year, which is 41% of the total volume in the Mekong River.

The discharge data of the Hau River in the dry season is shown in Table 2.1.1. The discharge is approximately 1000 m^3/s, which is 86,400,000 m^3 per day.

Table 2.1.1 River Discharge and Tidal Range Data in the Mekong Estuaries

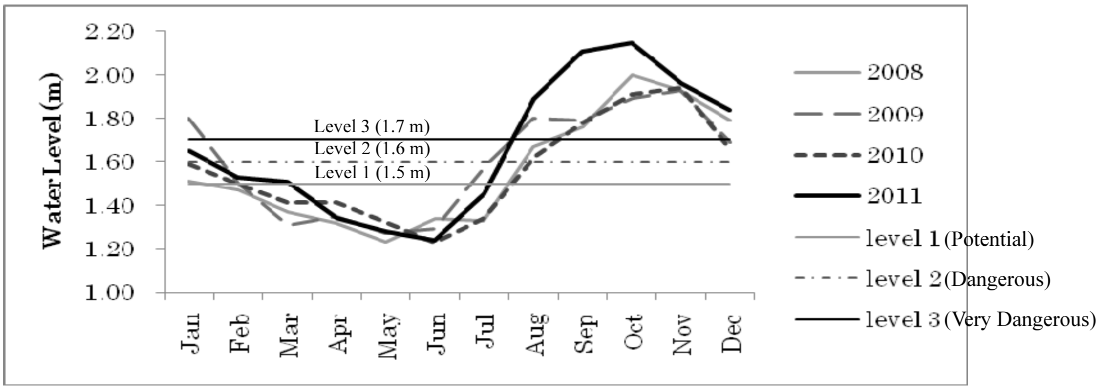
Estuary Name	Date	River Discharge (m^3/s)	Tidal Range (m)
Hau	April 8, 2005	1064	2.89
	April 9, 2005	1038	2.90
	May 21, 2005	930	2.62
	May 22, 2005	975	2.75
Co Chien – Cung Hau	April 21, 2005	680	2.07
	April 22, 2005	655	2.14

Source: Nguyen, A. D. and Savenije, H. H. G. (2006) *Salt intrusion in Multi-channel Estuaries: A Case Study in the Mekong Delta, Vietnam*. Hydrol. Earth Syst. Sci., 10: 743-754.

(3) Flood

The water level of the Hau River is affected by the flow from the upstream and tidal level.

The river flow from the upstream changes seasonally. The water level begins to rise in July and reaches highest in September or November, and then lowers in February. The monthly highest water level from 2008 to 2011 and water alarm levels at Can Tho Station are shown in Figure 2.1.3.



Source: JICA Study Team

Figure 2.1.3 Monthly Highest Water Level and Water Alarm Levels at Can Tho Station

According to H. T. L. Huong and A. Pathirana (2011), the Can Tho City was seriously flooded when the surcharges of water to drainage system coincide with high tide in the Hau River. The typical condition of flood in Can Tho City is when the rainfall at 50-100 mm per day combines with high tide. There was a serious flood in 2000 in the lower Mekong River Delta, which was one of the biggest floods in decades. The observed water level at the Can

Tho Hydrological Station during the flood was 1.9 m, which is the highest in the last 40 years. Flood inundation depth in 2000 is shown in Figure A1.8. The inundation depth in Can Tho City was 0.5-0.75 m. According to the Water Supply and Sewerage Company (WSSC), the elevation of existing water treatment plants are relatively high and the plants have never experienced inundation.

2.1.4 Geology, Geography, and Hydrogeology

Can Tho City is located in the alluvial plains of the Hau River. According to Can Tho City General Master Plan 2030, the volume of sediment, which was transferred through the Hau River, is 35 million m^3 per year. There are two soil layers below ground surface (up to El -50 m), which are Holocene (new alluvium) and Pleistocene (old alluvium).

In the detailed design of the Can Tho Bridge Project, standard penetration test, cone penetration test, in-situ pressure meter test, and laboratory soil test were conducted. The surface layer, varying from El 0 m to -50 m, is composed of soft clay where the N-value is less than 40. Layer St/C-1, which is reddish light brown silty clay with a little sand, lies within El -40 m to El -50 m . N-value varies from 13 to 60 in proportion to sand content. Layer S1 lies within El -70 m to El -95 m consisting of brownish color fine sand. Silt and clay are sporadically interlayered. N-value is 60 or more. The geophysical conditions of soil layers prepared in the Can Tho Bridge Project are shown in Figure A1.10 in Appendix A1.

2.1.5 Water Quality

(1) Existing Data

Water quality in Can Tho City is being monitored by the Center for Natural Resources and Environmental Monitoring under the Department of Natural Resources and Environment DONRE. The monitoring is conducted through sampling and laboratory tests, which are normally made three to four times a year and 12 times at heavily polluted canals.

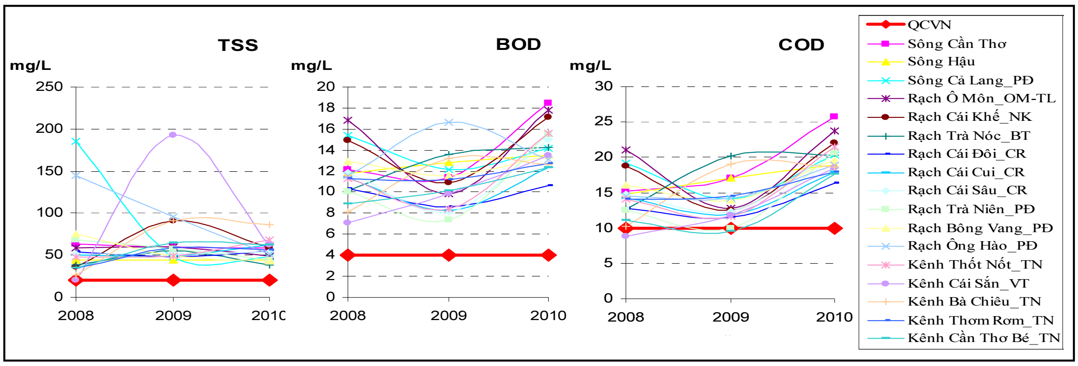
Profile surveys along the Hau River by boats are conducted twice a year from Tan Chau and Chau Doc to Tran De and Dinh An Port. Measurement was started in 2002 for the items of pH, salinity, and dissolved oxygen (DO).

The standards for surface water quality are described in QCVN 08:2008/BTNMT. Water quality levels are classified into four classes: A1, A2, B1, and B2 depending on water use and type of treatment.

Water quality of rivers and canals are evaluated under surface water quality standard.

The results of analysis for total suspended solids (TSS), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) are shown in Figure 2.1.4. The figure shows the results at (1) Cantho River, (2) Hau River, (3) Ca Lang River, (4) Cai San Canal, (5) Ba Chieu Canal,

(6) Thom Rom Canal, (7) Can Tho Be Canal, (8) Thot Not Canal, (9) O'Mon Canal, (10) Cai Khe Canal, (11) Tra Noc Canal, (12) Cai Doi Canal, (13) Cai Cui Canal, (14) Cai Sau Canal, (15) Tra Nien Canal, (16) Bong Vang Canal, and (17) Ong Hao Canal.



Source: 2010 Report on Existing Environmental Conditions in Can Tho City

Figure 2.1.4 Water Quality of Rivers and Canals in Can Tho City

Some canals are classified as heavily polluted canals, and sampling is being conducted 12 times a year. The canals are (1) Bo Ot Canal in Thot Not District, (2) Bon Tong Canal in Vinh Thanh town, (3) O'Mon Canal in Thoi Lai town, (4) Thi Doi Canal in Thoi Lai town, (5) Xao Xeo Canal in Thoi Lai town, (6) Dung Canal in Co Do town, (7) Cay Me Canal in O'Mon district, (8) Cai Chom Canal in O'Mon District, (9) Sang Trang Canal in Binh Thuy District, (10) Cai Khe Canal in Ninh Kieu District, (11) Tham Tuong Canal in Ninh Kieu District and (12) Ba Lang Canal in Cai Rang District. In the 2010 report on the existing environmental conditions in Can Tho City, the testing results were composed with the surface water quality standard. The pH, F^-, Cr^{6+}, As and Hg were below the A1 level, while the remaining items exceeded the A1 level.

(2) Site Survey

In the course of the Study, water quality sampling and testing were conducted on May 29, 2012 by the Study Team. A picture of water sampling process is shown in Figure 2.1.5. The test results of sampling and laboratory tests are shown in Table 2.1.2. Some of the test items are above the standard levels. Nevertheless, they will be appropriately treated at the water treatment process.

Source: JICA Study Team

Figure 2.1.5 Water Sampling

Table 2.1.2 Summary of Water Quality Test at O' Mon Proposed Site

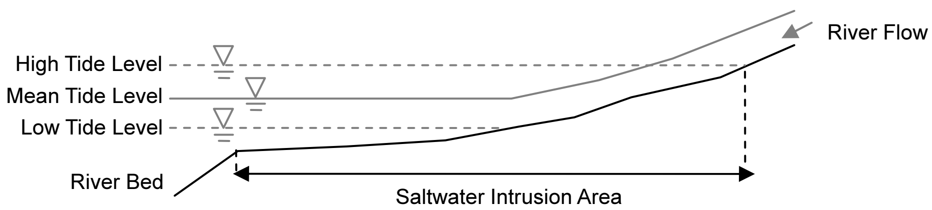
No	Specification	Units	Test Results	Surface Water Quality Standard (QCVN 08: 2008/BTNMT)			
				A1	A2	B1	B2
1	Total Suspended Solid (TSS)	mg/L	39	20	30	50	100
2	COD	mgO_2/L	18	10	15	30	50
3	BOD_5 (20℃)	mgO_2/L	8	4	6	15	25
4	Ammonia Nitrogen (NH4)	mg/L	0.22	0.1	0.2	0.5	1
5	Iron (Fe)	mg/L	1.69	0.5	1	1.5	2
6	Total oil and grease	mg/L	2	0.01	0.02	0.1	0.3

Source: JICA Study Team

2.1.6 Saltwater Intrusion

(1) General Condition of Saltwater Intrusion

Saltwater intrusion is a natural phenomenon in rivers having elevations below the mean sea level. It is basically caused by the difference between saltwater density (approximately 1.03) and freshwater density (approximately 1.0). A conceptual diagram of saltwater intrusion is shown in Figure 2.1.6.



Source: JICA Study Team

Figure 2.1.6 Conceptual Diagram of Saltwater Intrusion

At the edge of saltwater intrusion, saltwater and freshwater are mixed, and the concentration of salinity is lower than seawater. This mixture is called brackish water, of which salinity concentration is from 0.5 g/l to 30 g/l. For domestic water users, salinity concentration contour line of 1 g/l is used in Vietnam as a criterion. On the same manner, for agricultural water users, salinity concentration of 4 g/l is used as a criterion.

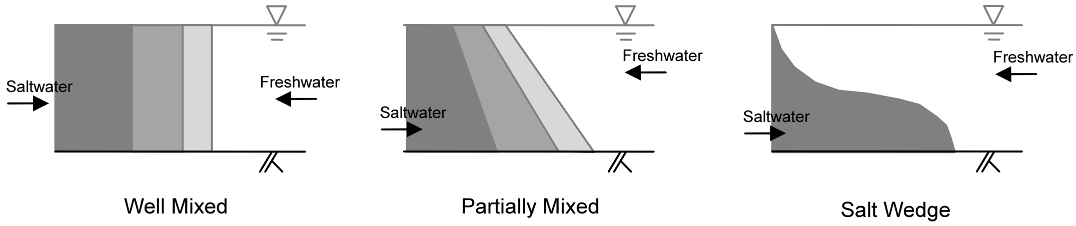
There are three types of mixing condition of saltwater and freshwater: namely, i) well mixed, ii) partially mixed, and iii) saltwater wedge.

i) Well mixed condition: There is no difference in salinity between surface water and bottom water. There is a gradient of density in the longitudinal direction of the river.

ii) Partially mixed condition: Saltwater and freshwater are mixed to some extent. Salinity increases from the surface to the bottom.

iii) Salt wedge condition: Saltwater and freshwater are in homogeneously mixed, and stratified as two layers. The upper layer is freshwater, and the lower layer is saltwater.

Conceptual diagrams of salinity mixing condition are shown in Figure 2.1.7.



Source: JICA Study Team

Figure 2.1.7 Types of Salinity Mixing Condition

(2) History of Saltwater Intrusion Countermeasures in the Mekong Delta

1) Countermeasures for agricultural water use in the Mekong Delta

Before the 1980s, in every dry season, agricultural areas in the Mekong Delta have been affected by salinity, amounting to 1.7–2.1 out of 3.5 million ha. In the period between 1980s and 1990s, a number of salinity control projects were implemented, constructing closure dams and sluice gates in the navigation canals networks in the delta region. Nowadays, salinity affects only 0.8 million ha every year due to the establishment of such facilities. However, the freshwater intakes near the estuary are usually affected by high concentration of salinity. It is reported that these intakes have to be closed for considerable long periods of time, varying from weeks to one or two months, to prevent salt intrusion.

According to JICA (2004), the Southern Regional Hydro-Meteorological Center in Ho Chi Minh City undertook salinity measurements for the 35 salinity stations. Of these stations, 28 stations are located in the delta area covering seven provinces which provide salinity intrusion forecasts to water users.

2) Recent Situation in Can Tho City

As described in Chapter 2.1.5, salinity measurements along the Hau River using a boat have been conducted by DONRE twice a year since 2002. A salinity contour line of 1 [g/l] in the 2004 dry season was found at 10-15 km downstream of the city. In the dry season of 2003 and 2005-2011, the line was found at 25-50 km downstream of the city. Salinity is located around the river mouth in rainy seasons.

According to the Can Tho City General Master Plan 2030, saltwater intrusion was found at 12 km downstream of the city in 2004 during the dry season, and came closer at 8 km downstream of the city in April 2010.

Based on the interview with DONRE, several salinity measuring equipment have been recently installed around the city with assistance from the Rockefeller Foundation. However, observation has not been started.

From the interview with DONRE, several water quality meters have been recently installed around the city under the Water-related Information System for the Sustainable Development of the Mekong Delta (WISDOM) project between Vietnam and Germany. The observation started in April 2012.

(3) Projection of Saltwater Intrusion

According to the description of Mekong River Commission, the extension of saltwater intrusion is largely affected by the flowrate of the Hau River and the tide water level. Therefore, the magnitude of saltwater intrusion will be very much affected by the change of climate and river flowrate control in the upstream area such as by dam construction.

The commission predicted that the dam will be constructed in the upstream even during climate change. Saltwater intrusion may be only up to 40 km from the estuary, since saltwater will be washed away to the estuary. While, there will be no dam construction in the upstream during climate change in 2020–2029, the saltwater intrusion will be 7 km downstream from the Can Tho City. On the same manner, it will be 3 km downstream from the Can Tho City in 2040–2049.

2.1.7 Saltwater Intrusion Survey in this Study

In the course of the Study, saltwater intrusion survey was carried out by the Study Team.

(1) Methodology of the Survey

Salinity measurement was conducted using water quality meter (WQC-24) and boat at high tide as shown in Figure 2.1.8.

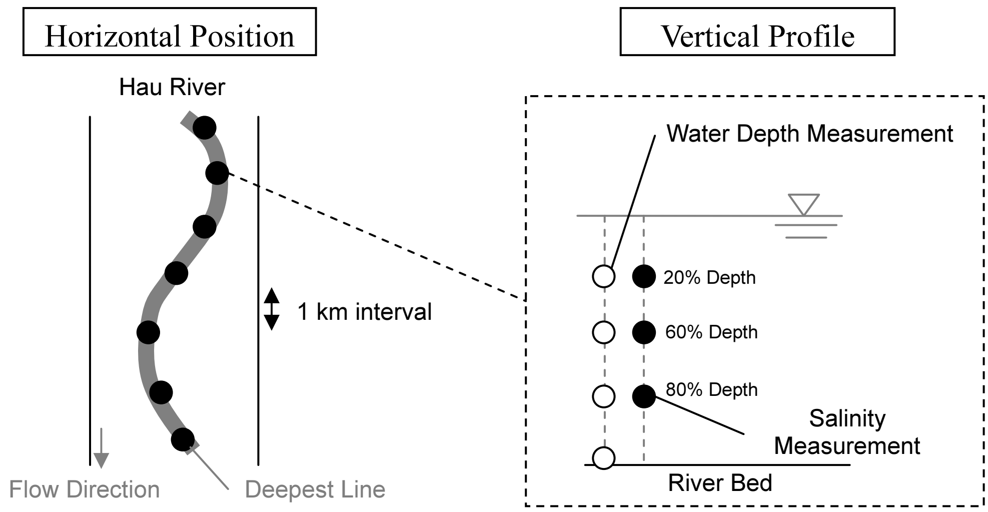
As preparatory works before the survey, cross sections of the Hau River were surveyed with GPS (Lowrance) and sonar (Lowrance S55A–USA), and the deepest point of the river cross section was identified. Salinity measurement was conducted along the deepest line. The longitudinal interval of measurement was approximately 1 km. In the vertical, the three-point method at 20%, 60%, and 80% of depth respectively were applied as shown Figure 2.1.9.

Temporary water level gauges were installed in the Hau River to know the time of high tide. The

Source: JICA Study Team

Figure 2.1.8 Salinity Measurement

water level was measured manually at one hour interval.

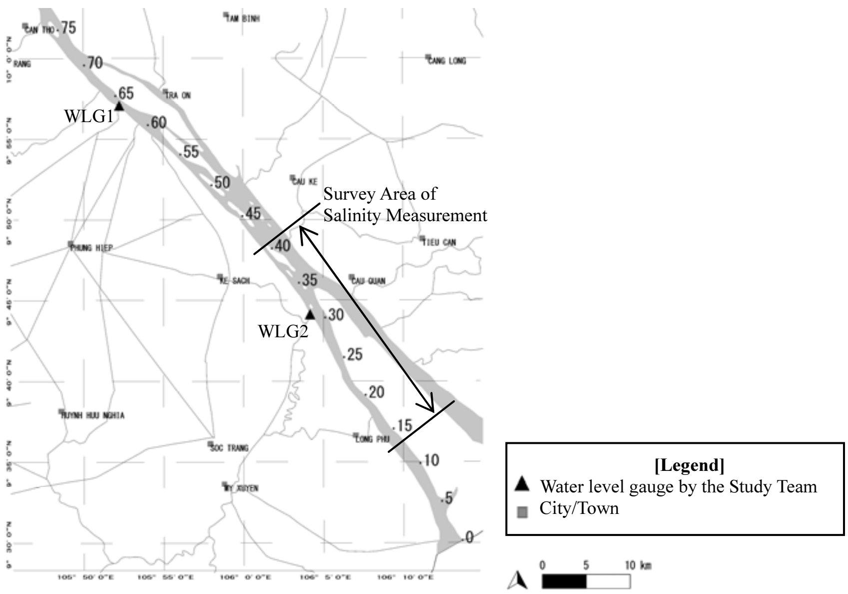


Source: JICA Study Team

Figure 2.1.9 Plan and Profile of the Survey

(2) Location and Period of the Survey

The location of the survey is shown in Figure 2.1.10. The survey was conducted 15-40 km upstream of the Hau River mouth. Can Tho City is located 77 km upstream of the river mouth.



Source: JICA Study Team

Figure 2.1.10 Location of Saltwater Intrusion Survey

The survey was conducted at neap and spring tides. The period of the survey is shown in Table 2.1.3.

Table 2.1.3 Period of the Saltwater Intrusion Survey

Type of Survey	Period	Note
Salinity Measurement	June 12 to 13 and 19 to 20, 2012	Neap tide on June 11, 2012 Spring tide on June 29, 2012
Water Level Observation	June 8 to 14, 2012 at WLG1 June 14 to 22 2012 at WLG2	WLG was relocated on June 14, 2012

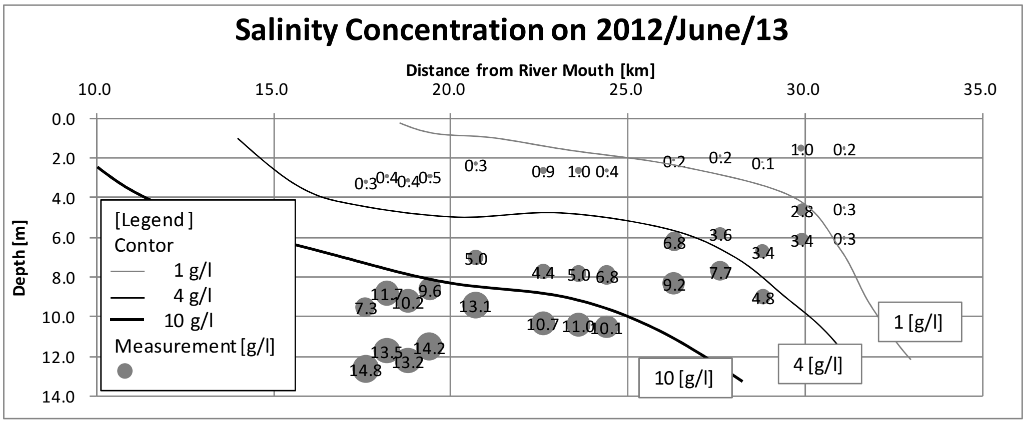
Source: JICA Study Team

(3) Results of the Survey

The results of the survey are shown in Figure 2.1.11. Saltwater intrusion was found approximately 30 km upstream of the Hau River mouth, which was approximately 45 km downstream of Can Tho City. The condition of saltwater was found to be partially mixed.

The survey was conducted in the beginning of the rainy season. It was confirmed that saltwater intrusion was located only near the estuary. It can be estimated that the probability of saltwater intrusion to Can Tho City is extremely minimal all year round.

However, long-term and constant measurements are requested to be carried out by DONRE.



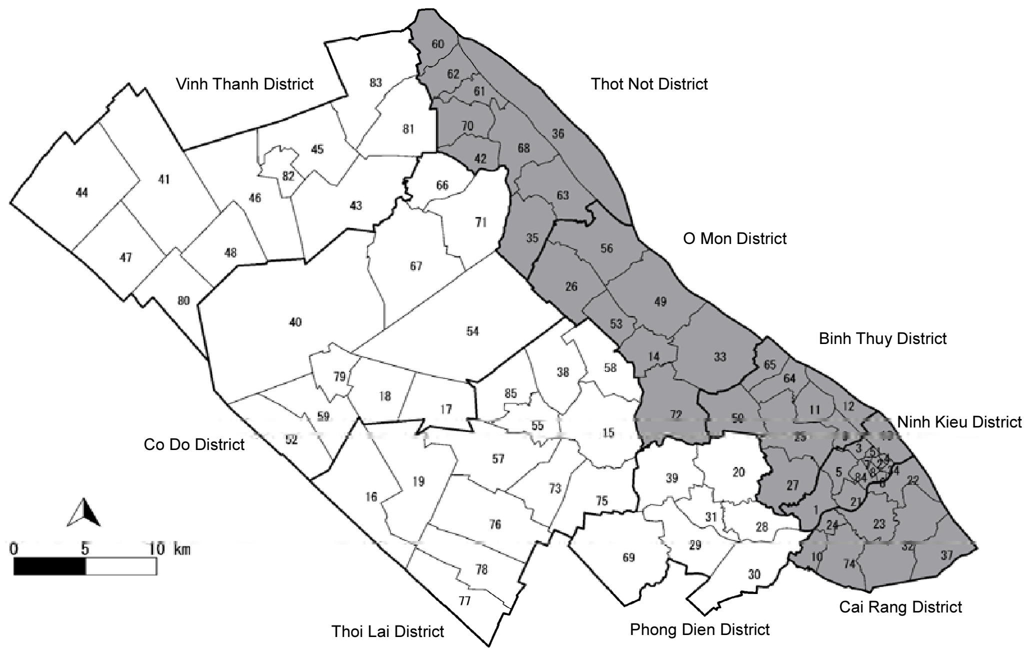
Source: JICA Study Team

Figure 2.1.11 Results of Salinity Measurement

2.2 Socioeconomic Conditions

2.2.1 Administrative Area of Can Tho City

In 2004, Can Tho Province was divided into Can Tho City and Hau Giang Province by a goverment decision, by then Can Tho City was designated as a centrally governed city. The administrative area of Can Tho City consists of five urban districts, namely, Ninh Kieu, O Mon, Binh Thuy, Cai Rang, and Thot Not; and four rural districts, namely Vinh Thanh, Co Do, Phong Dien, and Thoi Lai. These districts are composed of 44 wards (in urban districts) and 41 communes (in rural districts) as shown in Figure 2.2.1.



ID	Commune Name	ID	Commune Name	ID	Commune Name	ID	Commune Name	ID	Commune Name
1	AN BINH	21	HUNG LOI	41	THANH AN	61	THOT NOT	81	VINH BINH
2	AN CU	22	HUNG PHU	42	THANH HOA	62	THUAN AN	82	VINH THANH
3	AN HOA	23	HUNG THANH	43	THANH LOC	63	THUAN HONG	83	VINH TRINH
4	AN HOI	24	LE BINH	44	THANH LOI	64	TRA AN	84	XUAN KHANH
5	AN KHANH	25	LONG HOA	45	THANH MY	65	TRA NOC	85	XUAN THANG
6	AN LAC	26	LONG HUNG	46	THANH QUOI	66	TRUNG AN		
7	AN NGHIEP	27	LONG TUYEN	47	THANH THANG	67	TRUNG HUNG		
8	AN PHU	28	MY KHANH	48	THANH TIEN	68	TRUNG KIEN		
9	AN THOI	29	NHON AI	49	THOI AN	69	TRUNG LONG		
10	BA LANG	30	NHON NGHIA	50	THOI AN DONG	70	TRUNG NHOT		
11	BINH THUY	31	PHONG DIEN	51	THOI BINH	71	TRUNG THANH		
12	BUI HUU NGHIA	32	PHU THU	52	THOI DONG	72	TRUONG LAC		
13	CAI KHE	33	PHUC THOI	53	THOI HOA	73	TRUONG THANG		
14	CHAU VAN LIEM	34	TAN AN	54	THOI HUNG	74	TRUONG THANH		
15	DINH MON	35	TAN HUNG	55	THOI LAI	75	TRUONG THANH		
16	DONG BINH	36	TAN LOC	56	THOI LONG	76	TRUONG XUAN		
17	DONG HIEP	37	TAN PHU	57	THOI TAN	77	TRUONG XUAN A		
18	DONG THANG	38	TAN THANH	58	THOI THANH	78	TRUONG XUAN B		
19	DONG THUAN	39	TAN THOI	59	THOI XUAN	79	TT CO DO		
20	GIAI XUAN	40	THAN PHU	60	THOITHUAN	80	TT THANH AN		

Source: Statistical Yearbook 2011

Figure 2.2.1 Administrative Area of Can Tho City

2.2.2 Present Population and Population Projection

The population in Can Tho City is reported at 1.18 million according to the latest census data in 2009 surveyed by the General Statistics Office (GSO) under the Ministry of Planning and Investment. The population of Can Tho City is projected from 2010 to 2034 by GSO considering the historical trend from 1989 to 2009. The key factors such as mortality, migration, and fertility rates are set in consideration of the past trend.

In terms of fertility rate, four variants (high, medium, low, and constant) were presented based on different assumptions, and the medium variant (total fertility rate = 1.85 births/woman) was proposed to be the most feasible assumption in the GSO's report. Therefore, the JICA Study Team applied the population projection of Can Tho City based on medium fertility rate.

The population projection by GSO is shown in Table 2.2.1 and Figure 2.2.2. The projected population of Can Tho City has resulted in 1.37 million people in 2020 and 1.53 million people in 2030. In addition, the incremental ratios of the projected population in each year against the population in 2009 are shown in Table 2.2.1.

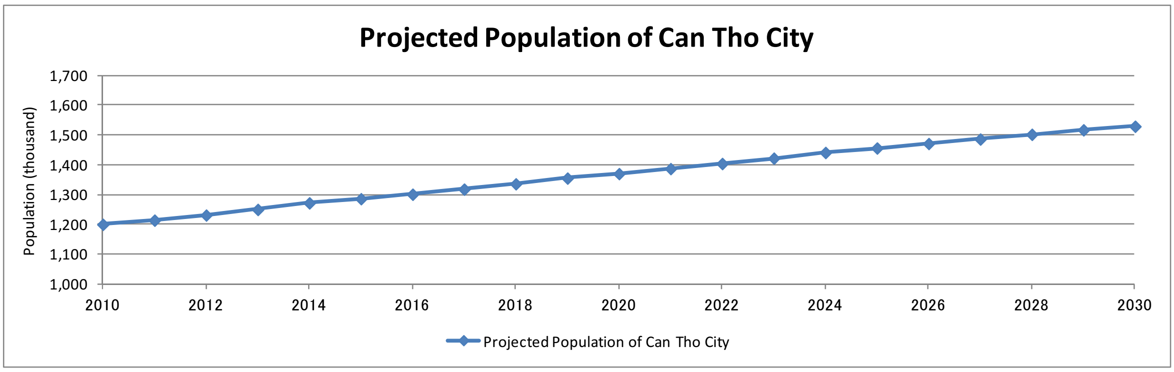
Population projection by GSO was not carried out at district and community levels, but only at provincial level. Therefore, population projection for the Study for ward and commune levels was carried out based on the census survey data of each district in 2009 and the projected population from 2010 to 2030 against the population in 2009 as shown in Table 2.2.1. The population of nine districts in Can Tho City predicted by JICA Study Team is summarized in Table 2.2.2.

Table 2.2.1 Population Projection of Can Tho City from 2010 to 2030 under Medium Fertility Rate **(Unit: Thousand)**

Year	2009	2010	2011	2012	2013	2014	2015	2016
Population	1,188	1,200	1,214	1,231	1,250	1,272	1,286	1,301
Ratio against 2009	*1.00*	*1.01*	*1.02*	*1.04*	*1.05*	*1.07*	*1.08*	*1.10*
Year	2017	2018	2019	2020	2021	2022	2023	2024
Population	1,318	1,336	1,355	1,370	1,387	1,404	1,422	1,441
Ratio against 2009	*1.11*	*1.12*	*1.14*	*1.15*	*1.17*	*1.18*	*1.20*	*1.21*
Year	2025	2026	2027	2028	2029	2030		
Population	1,456	1,471	1,486	1,502	1,517	1,529		
Ratio against 2009	*1.23*	*1.24*	*1.25*	*1.26*	*1.28*	*1.29*		

Note: 2009 is the actual population based on the Census survey.

Source: Population Projection for Vietnam, 2011 GSO



Source: Population Projection for Vietnam, 2011 GSO

Figure 2.2.2 Projected Population of Can Tho City from 2010 to 2030

Table 2.2.2 Population Projection per District in the Study Area (Unit: Thousand)

Districts	2010	2015	2020	2025	2030
1. Ninh Kieu	246,300	263,900	281,100	298,800	313,800
2. Binh Thuy	131,000	140,400	149,600	158,900	166,900
3. Cai Rang	114,700	122,900	131,000	139,200	146,200
4. O' Mon	87,100	93,400	99,500	105,700	111,000
5. Thot Not	159,800	171,300	182,500	193,900	203,600
6. Phong Dien	113,700	121,800	129,800	137,900	144,800
7. Co Do	125,300	134,300	143,100	152,100	159,700
8. Thoi Lai	100,300	107,500	114,500	121,700	127,800
9. Vinh Thanh	122,200	130,900	139,500	148,300	155,700
TOTAL	1,200,400	1,286,400	1,370,600	1,456,500	1,529,500

Source: JICA Study Team

2.2.3 City Plan and Land Use Plan

Can Tho City Master Plan 2030 was approved by the Can Tho PC in fiscal year 2012. Can Tho City has planned to develop the city from agricultural to industrial city according to the Decision 21/2007/QD-TTg. As shown in Table 2.2.3, about 82% of the whole land area was used for agricultural production, and only 5% for urban centers as of 2008. Whereas the ratio of agricultural land will be decreased to 55%, and urban center will be expanded up to 17% in 2030.

Table 2.2.3 Land Use in Can Tho City in 2008, 2020, and 2030

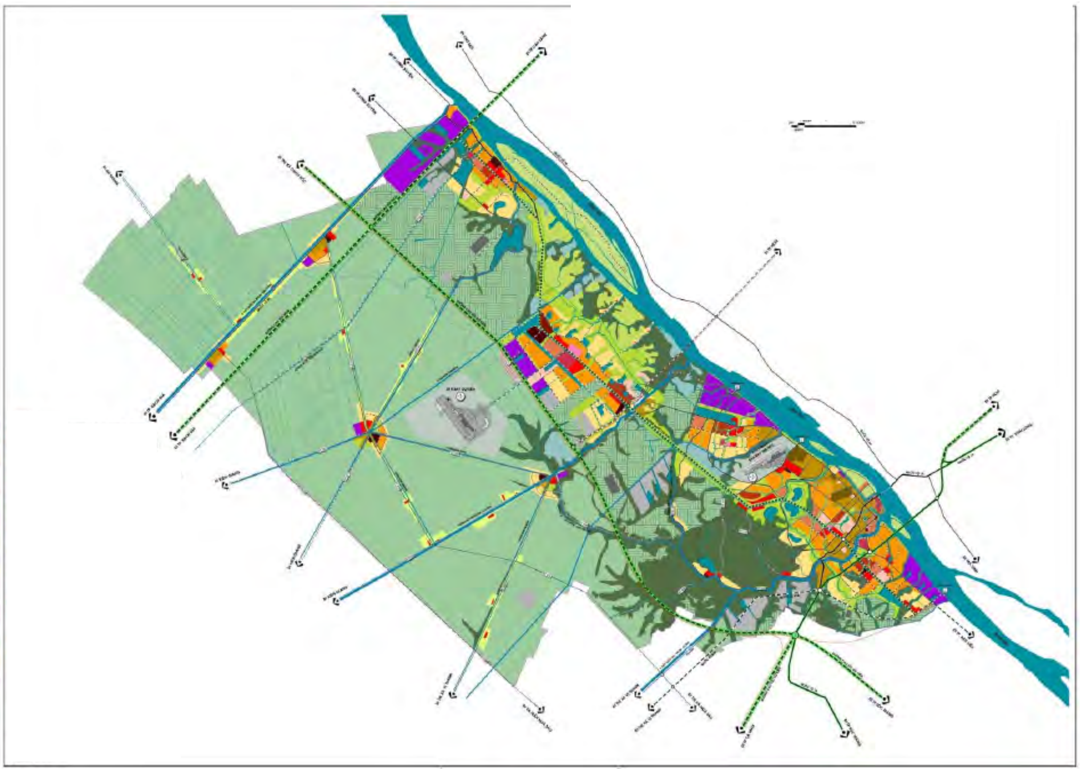
Categories		2008		2020		2030	
(1) Urban Area		**224 km^2**	**16%**	**282 km^2**	**20%**	**377 km^2**	**27%**
1) Urban Center		69 km^2	5%	164 km^2	12%	237km^2	17%
2) Outside Urban Center	Industrial	13 km^2	1%	19 km^2	1%	27 km^2	2%
	Non-industrial	142 km^2	10%	99 km^2	7%	113 km^2	8%
(2) Rural Area		**1,166 km^2**	**84%**	**1,108 km^2**	**80%**	**1,013 km^2**	**73%**
1) Agricultural		1,135 km^2	82%	897 km^2	65%	766 km^2	55%
2) Non- agricultural		31 km^2	2%	211 km^2	15%	247 km^2	18%
Total		**1,390 km^2**	**100%**	**1,390 km^2**	**100%**	**1,390 km^2**	**100%**

Source: Can Tho City Master Plan 2030

According to the existing land use condition and land use plan for 2030 shown in Figure 2.2.3 and Figure 2.2.4, urban districts are planned to be developed.

Source: Can Tho City Master Plan 2030

Figure2.2.3 Land Use Condition in Can Tho City in 2008



Source: Can Tho City Master Plan 2030

Figure2.2.4 Land Use Plan for 2030 in Can Tho City

2.2.4 Industries and Development Forecast

Can Tho City has planned to accerelate local development by appealing to private companies to invest in the industrial zone (IZ). In order to improve the accessibility of the city, several infrastructure projects such as the Can Tho Bridge, Can Tho International Airport, and Cai Cui International Seaport were completed in Can Tho City. The development of other infrastructures such as electricity, road, telecommunication, and water supply projects are ongoing in parallel with the development of IZ.

Presently, six IZs, namely Tra Noc Industrial Parks (No. 1 and 2), Hung Phu Industrial Park (1, 2A and 2B), and Thot Not Industrial Park (No. 1) are under operation, while three IZs are under the approval process by Can Tho City. The details of each IZ are summarized in Table 2.2.4.

Actual occupancy of settled factories are much lower than the registered ratio described in Table 2.2.4. This situation cannot be improved in the short-term because of the consecutive economic depression being experienced since 2007.

Table 2.2.4 Outline of Industrial Zones in Can Tho City

Name	Investor	Area (ha)	Operation Year	Registered Ratio (%)
Tra Noc 1 Industrial Park	Can Tho Industrial Parks Infrastructure Construction Company	135	1995	100
Tra Noc 2 Industrial Park	Can Tho Industrial Parks Infrastructure Construction Company	157	1998	95
Hung Phu 1 Industrial Park	Sai Gon-Can Tho Industrial Parks Joint Stock Company	262	2006	13
Hung Phu 2A Industrial Park	BMC Building Material and Commercial Company	134	2009	16
Hung Phu 2B Industrial Park	Single Member Limited Liability Can Tho Industrial Parks Infrastructure Construction Company	67	2009	21
Thot Not 1 Industrial Park	Thot Not Industrial Parks Infrastructure Construction Center	104	2009	32
O'Mon Industrial Park	Not Decided	600	-	Under Approval
O'Mon Northeren Industrial Park	Not Decided	400	-	Under Approval
Thot Not 2 Industrial Park	Thot Not Industrial Parks Infrastructure Construction Center	400	-	Under Approval

Source: Can Tho Export Processing and Industial Zones Authority (SEPIZA), 2012

For years, some factories in Tra Noc Industrial Parks (No.1 and 2) have exploited ground and surface water for their own use even though they can use the water from Can Tho Water Supply and Sewerage Company., Ltd (WSSC). Exploitation of groundwater is prohibited by the regulation of DONRE to avoid land subsidence, and the consumption of water from WSSC by the factories may increase in the near future.

Treated water from WSSC is not supplied to the Hung Phu Industrial Parks (1, 2A and 2B) and Thot Not Industrial Park currently because the pipeline installation has not been completed. The factories in these IZs may have exploited groundwater for their own use. After the connection of pipelines to these IZs, the consumption of WSSC's water may increase in proportion to the increase of factories in these IZs.

2.2.5 National and Can Tho City's Economic Activities and Indices

(1) National Economic Activities and Indices

1) Macro-economics

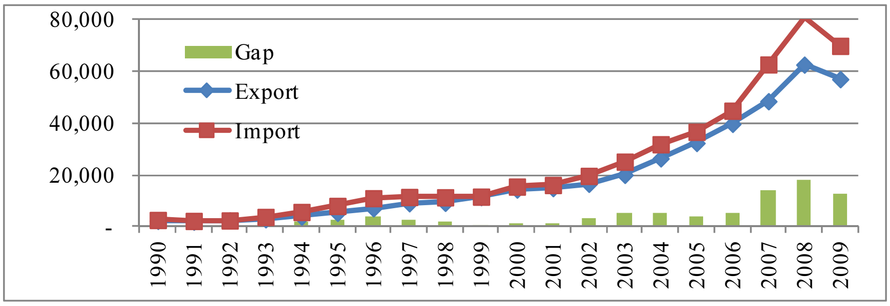
The financial credibility of a country is generally examined and rated by those rating agencies, such as Moody's and S&P, whose rating results are utilized globally for investor's decision makings. Currently, the credit ratings of Vietnam are below the investment grade (B1 by Moody's and BB- by S&P) due to account deficit and instability of financial system despite rapid economic growth in recent years. Inflation rate (expressed as "Consumer Price Index") showed a historic increase of 23% in August 2011 and an annual increase of 18.10% as shown in Table 2.2.5 in the context of trade deficit, which evokes devaluation of VND. The value of VND is devaluating steadily as shown in Table 2.2.5 since the trade deficit of Vietnam is growing every year as shown in Figure 2.2.5. The Resolution 11/NQ-CP was issued by the government in February 2011 aiming for macroeconomic stability and cooling down the overheated economy. The resolution brought the high inflation rate down to 17.3% in January 2012.

Table 2.2.5 Macroeconomic Indicators

	2002	2003	2004	2005	2006
Consumer Price Index in Vietnam (*1)	4.00%	2.90%	9.70%	8.80%	6.60%
Producer Price Index in Vietnam (*2)	1.90%	2.20%	7.70%	4.50%	4.20%
VND/JPY (*3)	129.74	146.25	152.14	134.79	135.13
USD/VND (*3)	15,401	15,642	15,785	15,918	16,043
	2007	2008	2009	2010	2011
Consumer Price Index in Vietnam (*1)	12.60%	19.90%	6.50%	11.80%	18.10%
Producer Price Index in Vietnam (*2)	6.90%	21.80%	7.40%	12.60%	18.40%
VND/JPY (*3)	141.87	193.87	200.0509	239.7023	272.1126
USD/VND (*3)	16,003	17,486	18,479	19,498	21,049

Source: (*1) Producer prices, % each year, end of period (General Statistics Office)
(*2) Consumer price index, % each year, end of period (General Statistics Office)
(*3) Bloomberg

(USD in millions)



Source: General Statistics Office of Vietnam

Figure 2.2.5 Balance of Trade

2) Financial status

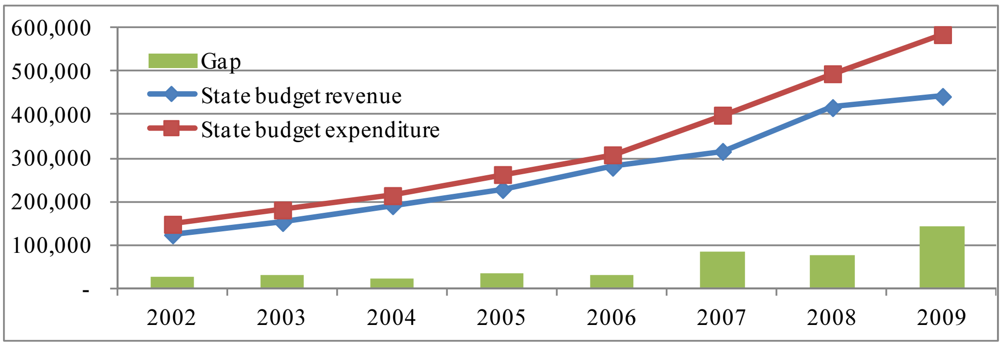
Vietnam has a chronic account deficit problem as shown in Figure 2.2.6, and such deficit is mainly composed of its repayment obligations for ODA loan. This leads to the situation where the ratio of general government debt to government revenue increased dramatically in 2010 and 2011. As most of the public debt appears to be composed of ODA loan for infrastructure demand, the Government of Vietnam needs to raise funds for further infrastructure investments from private sector, and thus, reducing its dependency on the public debts. According to a rating agency, current budgetary balance can stay sustainable as long as the economy and inflation rate continue to grow, although the deficit amount seems too large under the current level of GDP. Table 2.2.6 shows the basic financial indicators of Vietnam.

Table 2.2.6 Financial Indicators

	2006	2007	2008	2009	2010	2011
Real GDP (% change)	8.2	8.5	6.3	5.3	6.8	5.9
General Government Financial Balance/GDP (%)	-1	-0.7	-4.3	-5.9	-5.8	-4.1
General Government Debt/GDP (%)	35.2	35.9	34.5	40.5	42.8	39.7
General Government Debt/Revenue (%)	97.8	95.4	119.5	106.7	151.5	148.2
General Government Internal Payment/Revenue (%)	3.9	4	5.3	4.1	5.5	5.3
Current Account Balance/GDP (%)	-0.3	-9.8	-11.9	-6.8	-4	-4.5

Source: "Credit opinion on Government of Vietnam", February 14, 2012, Moody's

(VND billions)



Source: General Statistics Office of Vietnam

Figure 2.2.6 Fiscal Balance

(2) Economic Activities and Indices in Can Tho City

1) Macroeconomics

The economy of Can Tho City is growing as the nation's economy grows. Regarding the indicator for inflation, the increase in retail price in 2011 was over 15% as shown in Table 2.2.7.

Table 2.2.7 Retail Price Indicator in Can Tho City

	2005	2008	2009	2010	2011
Average retail price changes of consumer goods and services (%)	8.71	20.24	6.53	12.25	15.52

Source: "Statistical Yearbook 2011", May 2012, Statistical Office of Can Tho City

2) Financial status

(a) Revenue

The revenue of Can Tho City shown as “total revenue” of the local state budget in Table 2.2.8 increased by 17.8% p.a. from 2010 to 2011, 32.7% from 2009 to 2010, and 29.8% from 2008 to 2009. In general, the “revenue of economy in area” and “tax on handout trade services” are the major revenue items, and respectively, each accounted for approximately 20% of the total revenue. Followed by, “revenues from foreign invested economic sector” accounted for 15% of the total revenue in 2011, and its share has been increasing in recent years.

Table 2.2.8 Revenue of Can Tho City

(VND in millions)

		2008	2009	2010	2011
Total Revenue		**3,748,322**	**4,581,529**	**5,447,788**	**6,245,269**
I	**Revenue of Can Tho City**	2,735,408	3,549,529	4,709,523	5,549,001
1	Revenues of economy in area	771,742	894,038	1,228,127	1,229,744
2	Tax on handout trade services	762,831	855,705	1,189,548	1,328,953
3	Fee on registry	104,457	135,397	170,122	191,763
4	Tax on agriculture	346	625	619	473
5	Tax on housing and land	17,961	18,973	26,174	31,295
6	Tax on income	82,645	178,141	268,094	366,172
7	Lotto	290,000	388,000	430,000	551,997
8	Fee and fee on transportation	107,649	229,801	173,105	172,236
9	Fee on registry	55,191	77,048	97,950	145,911
10	Revenue on land use	63,285	2,313	47	0
11	Revenue on land use (Rentals)	222,787	347,091	505,903	416,869
12	Revenue on house sale	19,411	84,112	41,713	15,928
13	Revenue on house rent	39,555	64,562	64,526	108,862
14	Other revenues	29,094	41,803	42,457	83,760
15	Revenues from foreign invested economic sector	168,454	231,920	471,138	905,038
II	**Custom Tax**	**1,012,914**	**1,032,000**	**738,265**	**696,268**

Source: “Statistical Yearbook 2011”, May 2012, Statistical Office of Can Tho City

(b) Expenditure

The expenditure of Can Tho City shown as “total expenditure from state budget” in Table 2.2.9 increased by 19.2% p.a. from 2010 to 2011, 27.7% from 2009 to 2010, and 26.4% from 2008 to 2009. Its fiscal balance has dropped into deficit in 2011. A significant increase in “capital expenditure” in 2011 as shown in Figure 2.2.9 has caused such deficit. It reached approximately 50% of total expenditure in 2011. This trend of large capital investment is mainly arising from the need for development of various infrastructures. In order to meet such requirements without degrading the financial conditions any further, Can Tho City should take measures to start involving private investors to utilize their money to finance infrastructure projects for the city.

Table 2.2.9 Expenditure in Can Tho

(VND in millions)

			2008	2009	2010	2011
	Total expenditure from state budget		**3,309,681**	**4,182,531**	**5,339,737**	**6,367,016**
I	**Expenditure on development investment**		**941,367**	**1,729,140**	**1,786,947**	**3,467,018**
	1	Capital expenditure	895,047	1,622,004	1,596,689	3,467,018
	2	Expenditure for governmental company	-	-	-	-
II	**Frequent expenditure**		**1,243,085**	**1,607,996**	**1,975,553**	**2,524,463**
	1	Expenditure for economic services	59,647	64,333	91,980	147,116
	2	Expenditure on education and training	565,292	637,900	804,257	1,038,165
	3	Expenditure on health	125,156	195,023	230,847	351,171
	4	Expenditure on science, technology, and environment	49,524	97,509	16,687	26,690
	5	Expenditure on culture	23,283	23,601	29,753	47,588
	6	Expenditure on broadcasting and television	11,751	12,244	16,413	26,251
	7	Expenditure on sports	15,054	17,296	23,780	38,035
	8	Social relief	42,911	48,499	77,267	123,584
	9	Expenditure on general public administration	265,725	243,393	435,983	360,297
	10	Security and national defense	58,816	47,946	83,210	101,058
	11	Policy to subsidize	1,398	841	504	806
	12	Expenditure for villages	-	167,951		
	13	Other	24,521	51,460	85,802	137,235
III	**Repayment of outstanding balance loan (principal only)**		**640,138**	**629,712**	**639,796**	**-**
IV	**Addition to financial reserve fund**		**1,380**	**1,380**	**1,380**	**1,380**
V	**Cost for the target programs**		**54,588**	**66,044**	**103,070**	**72,320**
VI	**Reserve from state budget**		**15,130**	**-**	**-**	**2,240**
VI	**Other expenditure**		**-**	**-**	**-**	**-**
VII	**Administrative expenditure for local authority**		**413,993**	**148,259**	**832,991**	**299,595**
Missing amount(*)			**7**	**-**	**79,070**	**126,467**

Source: "Statistical Yearbook 2011", May 2012, Statistical Office of Can Tho City
(*) Difference between total expenditure from state budget and total amount of each items described in the "Statistical Yearbook 2011", May 2012, Statistical Office of Can Tho City.

CHAPTER 3 EXISTING CONDITIONS OF THE WATER SUPPLY IN CAN THO CITY

3.1 Existing Water Supply System

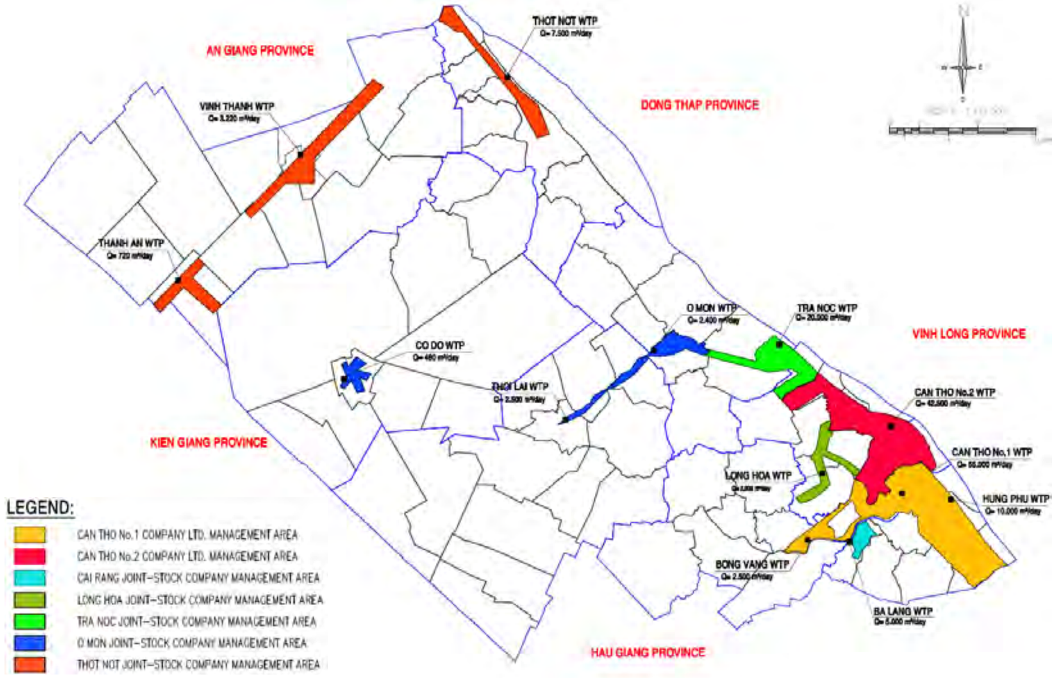
3.1.1 Control and Management of Current Water Supply

(1) Allocation of Water Supply System in Can Tho City

According to the city plan, there are two other administrative classifications in addition to those previously discussed in Section 2.2.1, namely, urban area and rural area. The Can Tho Water Supply and Sewerage Co., Ltd. (WSSC) and its related companies, which include five subsidiaries and one affiliate, manage the water supply system in the urban area under the supervision of the Department of Construction (DOC). Meanwhile, the Department of Agricultural and Rural Development (DARD) manages the water supply system in rural area.

(2) Urban Water Supply System

There are 13 water treatment plants (WTPs) with their service areas defined as urban water supply system. These WTPs are managed by seven organizations, comprising of WSSC, No. 2 Water Supply Limited Company (No. 2 LTC), and five joint stock companies (JSCs), such as Thot Not, O'Mon, Tra Noc, Cai Rang, and Long Hoa JSCs. The service areas of WSSC and its related companies (all are comprehensively called as Water Companies) are shown in Figure 3.1.1 and Table 3.1.1.



Source: WSSC

Figure 3.1.1 Service Areas of WSSC and its Related Companies

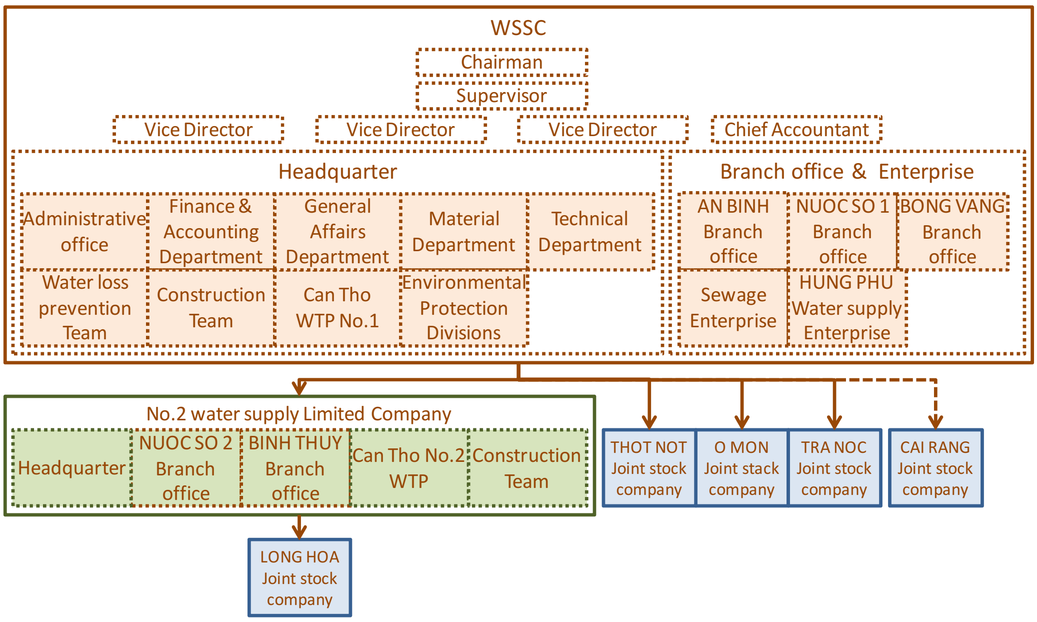
Table 3.1.1 Service Areas of WSSC and its Related Companies

Water Managing Organization	WTP
Can Tho Water Supply & Sewerage Co., Ltd.	Can Tho No. 1 WTP, Bong Vang WTP, Hung Phu WTP
No. 2 Water Supply Limited Company	Can Tho No. 2 WTP
Thot Not Joint Stock Company	Thot Not WTP, Vinh Tanh WTP, Thanh An WTP
O Mon Joint Stock Company	O Mon WTP, Thoi Lai WTP, Co Do WTP
Tra Noc Joint Stock Company	Tra Noc WTP
Cai Rang Joint Stock Company	Ba Lang WTP
Long Hoa Joint Stock Company	Long Hoa WTP

Source: JICA Study Team

Included in the scope of work of the Water Companies are the following: 1) construction and rehabilitation works in the service areas; 2) O&M works of the WTPs and water networks; and 3) water tariff collection in the service areas. The trunk mains and distribution networks of the companies are not connected with each other, but are separated by sluice valves. Thus, the water supply system in Can Tho City is operated and managed independently by the Water Companies. In the economic point of view, the WTPs for the flat urban area like Can Tho City shall be bigger. At present, there are 13 small operating WTPs.

The organization framework of Water Companies is composed of WSSC, No. 2 LTC, and five JSCs as shown in Figure 3.1.2. The WSSC's main functions, such as technical, financial, and administrative aspects, are performed at the head office while only the O&M of WTPs and tariff collection works are conducted by the branch offices and enterprise. The No. 2 LTC and its two branches manage the Can Tho No. 2 WTP and the distribution area, with the two branches handling tariff collection. The five JSCs manage their own WTPs and networks including tariff collection works.



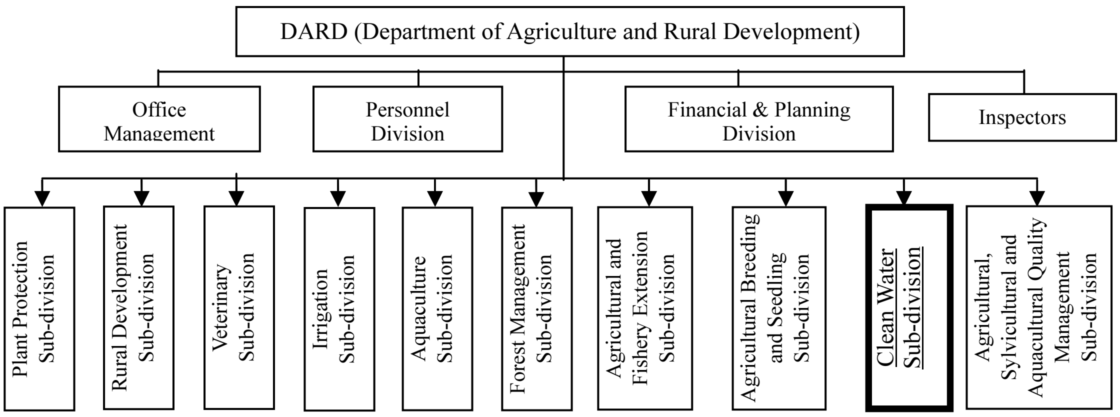
Source: WSSC

Figure 3.1.2 Organizational Chart of WSSC and its Related Companies

(3) Rural Water Supply System

The organizational chart of DARD is shown in Figure 3.1.3. The Clean Water Sub-division of DARD manages the water supply services in the rural areas of Can Tho City with 56 staff working in the central office. As of 2012, it manages 431 water supply stations which provide treated water for 61,708 households in total. The water source of all the facilities rely on groundwater except for two stations that abstract river water. The production capacity of the wells is 120-960 m^3/day.

Approximately 80% of the initial capital investment of rural water supply facilities was procured by Can Tho PC, while the rest of the investment was covered by users. Likewise, O&M cost is covered by water tariff. The current water tariff is being levied by a fixed rate of VND 3000/m^3 including 5% VAT and VND 180/m^3 as environmental protection fee in compliance with the Decision No. 2862/QD-UBND issued by Can Tho PC.



Source: DARD

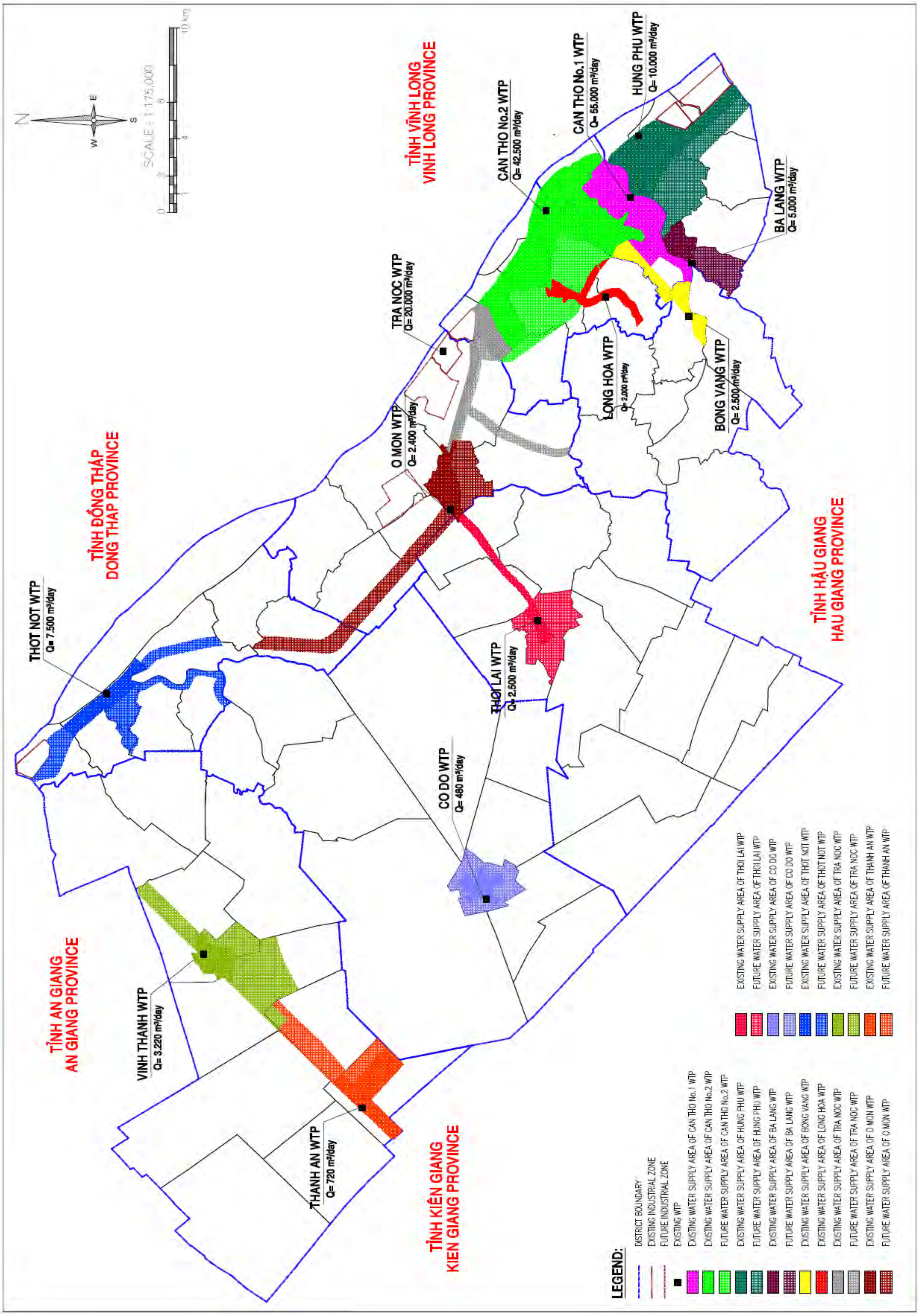
Figure 3.1.3 Organizational Chart of DARD

3.1.2 Current Water Demand and Consumption

(1) Water Supply Area and Service Area Population

The 13 WTPs operated by Water Companies and their distribution areas in 2012 are shown in Figure 3.1.1. The service area of the Water Companies is planned to be expanded based on the mutual agreement among DOC, WSSC, and DARD. The map of the water supply area for the target year of 2020, as shown in Figure 3.1.4, was approved by Can Tho PC within FY 2012.

The total population, served population, and service ratio in the Water Companies' service area in 2012 were estimated and summarized in Table 3.1.2 and Appendix B1. The total population in each WTP's service area was calculated as the population of districts, described in Section 2.2.2, multiplied by the area ratio of future distribution area and related districts. Likewise, the served population was calculated by the area ratio of current distribution area and related districts while the service ratio was calculated by the ratio of served and total population.



Source: DOC

Figure 3.1.4 Water Supply Area Map for Target Year 2020

Table 3.1.2 Population in Each Service Area (as of 2012)

WTP	Population in Service Area	Served Population	Service Ratio
Can Tho No. 1	156,200	148,400	95%
Can Tho No. 2	159,100	140,700	88%
Tra Noc	28,600	14,300	50%
Hung Phu	48,900	16,500	34%
Thot Not	49,500	28,000	57%
Bong Vang	8,700	8,000	92%
Long Hoa	11,100	7,900	71%
Ba Lang	21,600	12,000	56%
O Mon	35,300	8,200	23%
Thoi Lai	14,600	6,200	42%
Co Do	11,600	5,700	49%
Vinh Thanh	20,300	15,200	75%
Thanh An	14,800	8,200	55%
Total	535,300	419,400	78%

Note: Population in service area is that in the planned area in 2020, as shown in Figure 3.1.4, and served population is that in the service area in 2012. The population was calculated by using the Geographical Information System (GIS) software. In the calculation process, the city area was separated by 250 m mesh and the population in each mesh was calculated based on statistical population data in consideration of residential location. The population in service area and served population were estimated by using the calculated population data in each mesh.

Source: JICA Study Team

(2) Water Production

The water production in each WTP from February to May 2012 is summarized in Table 3.1.3. The water productions in Can Tho No. 1 and Can Tho No. 2 WTPs, where the largest population is served, are overloaded with more than 10% of their capacity because the expansion of existing WTPs cannot catch up with the water demand growth. It showed that the capacities of WTPs in the center of Can Tho City are not enough and expansion plans are required as soon as possible.

Table 3.1.3 Water Production in Each WTP

WTPs	Urban /Rural	Capacity in 2012	February, 2012		March, 2012		April, 2012		May, 2012		Average	
			Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)
Can Tho-1 Bong Vang	Urban	57,500	77,921	136%	66,001	115%	72,291	126%	66,305	115%	70,433	122%
Can Tho-2	Urban	42,500	53,158	125%	43,265	102%	47,763	112%	46,977	111%	47,657	112%
Tra Noc	Urban	20,000	9,504	48%	9,738	49%	10,318	52%	10,498	52%	10,025	50%
Hung Phu	Urban	10,000	3,649	36%	3,652	37%	3,991	40%	3,820	38%	3,779	38%
Thot Not	Urban	7,500	7,969	106%	6,945	93%	7,323	98%	7,371	98%	7,388	99%
O Mon	Urban	2,400	2,995	125%	2,589	108%	2,779	116%	2,428	101%	2,690	112%
Long Hoa	Urban	2,000	1,882	94%	1,617	81%	1,728	86%	1,732	87%	1,736	87%
Ba Lang	Urban	5,000	3,997	80%	3,503	70%	4,037	81%	3,729	75%	3,810	76%
Thoi Lai	Rural	2,500	619	25%	476	19%	562	22%	487	19%	534	21%
Co Do	Rural	480	771	161%	606	126%	732	152%	654	136%	688	143%
Vinh Thanh	Rural	3,220	609	19%	550	17%	555	17%	625	19%	584	18%
Thanh An	Rural	720	1,123	156%	1,014	141%	1,000	139%	1,050	146%	1,045	145%
Total		153,820	164,196	107%	139,956	91%	153,077	100%	145,676	95%	150,370	98%
Can Tho-1,2		100,000	131,078	131%	109,266	109%	120,054	120%	113,282	113%	118,090	118%

Source: WSSC

(3) Water Consumption and Non-revenue Water Ratio

The non-revenue water (NRW) volume was obtained from the difference between the produced water and billed water volumes. The billed water volume and NRW ratio from February 2012 to May 2012 are summarized in Table 3.1.4.

Table 3.1.4 Billed Water Volume (Water Consumption)

WTPs	Urban /Rural	February, 2012		March, 2012		April, 2012		May, 2012		Average	
		Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)
Can Tho-1* Bong Vang	Urban	43,936	43.6%	38,477	41.7%	43,563	39.7%	41,135	38.0%	41,709	40.8%
Can Tho-2	Urban	34,511	35.1%	29,591	31.6%	33,704	29.4%	31,433	33.1%	32,243	32.3%
Tra Noc	Urban	8,634	9.2%	9,149	6.0%	9,642	6.6%	9,886	5.8%	9,342	6.8%
Hung Phu	Urban	3,452	5.4%	2,792	23.5%	3,202	19.8%	3,033	20.6%	3,111	17.7%
Thot Not	Urban	6,269	21.3%	5,180	25.4%	5,197	29.0%	5,680	22.9%	5,568	24.6%
O Mon	Urban	1,733	42.1%	1,491	42.4%	1,595	42.6%	1,552	36.1%	1,589	40.9%
Long Hoa	Urban	1,521	19.2%	1,143	29.3%	1,490	13.8%	1,377	20.5%	1,379	20.6%
Ba Lang	Urban	2,988	25.2%	2,737	21.9%	3,096	23.3%	3,067	17.7%	2,971	22.0%
Thoi Lai	Rural	507	18.1%	420	11.8%	510	9.3%	467	4.1%	475	11.0%
Co Do	Rural	685	11.3%	575	5.1%	660	9.8%	654	0.0%	642	6.7%
Vinh Thanh	Rural	516	15.2%	460	16.3%	448	19.3%	503	19.6%	481	17.7%
Thanh An	Rural	862	23.3%	781	23.0%	758	24.2%	801	23.7%	799	23.5%
Total		105,614	35.7%	92,798	33.7%	103,865	32.1%	99,588	31.6%	100,309	33.3%
Average of Can Tho-1,2		78,448	40.2%	68,069	37.7%	77,267	35.6%	72,569	35.9%	73,952	37.4%

Note: The water tariff collection in the distribution area of Can Tho No. 1 and Bong Vang WTPs is managed by the head office and An Vinh branch of WSSC. The breakdown of billed volume in each distribution area was not recorded by WSSC; therefore, the billed volume and NRW ratio in the WSSC service area are summarized in this table.
Source: WSSC

The average NRW ratio was 33% in the service area of Water Companies, and 37% in Can Tho No. 1 and Can Tho No. 2 WTPs. The NRW ratios in the service areas of Can Tho No. 1 and Bong Vang WTPs, and O Mon WTPs were very high at more than 40%.

(4) Unit Water Consumption

The five categories for water tariff setting in Can Tho City include the following: 1) poor households, 2) residential households, 3) institution, 4) industry, and 5) commercial. The average water consumption in each category in 2011 is shown in Table 3.1.5.

Table 3.1.5 Water Consumption in 2011

Water Company	WTP	Average Water Consumption in 2011 (Billed Volume) (m3/day)					
		Poor Households	Residential Households	Institution	Industry	Commercial	Total
WSSC	Can Tho No.1	136	18,718	4,116	623	6,553	30,144
An Binh	Bong Vang	7	6,099	1,208	266	972	8,551
Hung Phu	Hung Phu	3	1,898	223	236	285	2,645
Can Tho-2 JSC	Can Tho No.2	36	13,500	2,661	1,295	4,282	21,774
Binh Thuy		25	2,959	425	40	842	4,291
Tra Noc JSC	Tra Noc	22	1,630	71	5,440	569	7,732
Thot Not JSC	Thot Not	38	3,268	404	148	1,062	4,921
Vinh Thanh	Vinh Thanh, Thanh An	40	739	165	16	176	1,136
O Mon JSC	O Mon, Thoi Lai, Co Do	60	1,682	250	89	304	2,385
Long Hoa JSC	Long Hoa	8	816	110	6	91	1,031
Cai Rang JSC	Ba Lang	8	2,051	242	66	289	2,655
Total		**383**	**53,360**	**9,875**	**8,224**	**15,424**	**87,266**
			53,744				
Ratio			**61.6%**	**11.3%**	**9.4%**	**17.7%**	**100%**

Source: WSSC

As shown in Table 3.1.5, the ratios of water consumption for each category are 62% for domestic, 11% for institutional, 9% for industry, and 18% for commercial. The ratio of non-domestic use in Can Tho City is 38% in total.

The unit water consumption for domestic use differs depending on the urban classification. The average unit water consumption in 2011 in Can Tho City was estimated at 131 L/c/d, with 142 L/c/d in urban area in urban district, 126 L/c/d in suburban area in urban district, and 59 L/c/d in rural district as shown in Table 3.1.6.

Table 3.1.6 Unit Water Consumption for Domestic Use in 2011

Water Company	WTP	Domestic water consumption (m3/s)	Served Population (thousand)	Unit Consumption (L/c/d)
I. Urban Distict_ Urban Area				
WSSC	Can Tho No.1	24,960	145.5	142
An Binh	Bong Vang		7.8	
Can Tho-2 JSC	Can Tho No.2	16,521	138.0	
Binh Thuy				
II. Urban Distict_ Suburban Area				
WSSC_Hung Phu	Hung Phu	1,901	16.2	126
Tra Noc JSC	Tra Noc	1,652	14.0	
Thot Not JSC	Thot Not	3,306	27.5	
Long Hoa JSC	Long Hoa	824	7.8	
Cai Rang JSC	Ba Lang	2,059	11.8	
II. Rural District				
Vinh Thanh	Vinh Thanh	779	14.9	59
	Thanh An		8.1	
O Mon JSC	O Mon	1,742	8.1	
	Thoi Lai		6.1	
	Co Do		5.6	
Total in Can Tho City		53,744	411.3	131

Source: WSSC

(5) Tariff Collection

Meter readings and tariff collection are carried out by the staff of Water Companies every month. The procedure from meter reading to tariff collection is as follows:

- The staff visits each household to read the meter;
- Water bill is prepared at the head office of WSSC or Can Tho No. 2 LTC;
- The staff visits again each household to distribute the water bill and collect water tariff; and
- In the absence of the consumer during the collection of water tariff, the water bill can be paid at the office of Water Companies later.

If the consumer cannot pay the water bill within a month, the household will be disconnected from the services until such time the payment is made.

(6) Non-revenue Water Ratio Reduction

The WSSC established the Water Loss Prevention Team to reduce the NRW ratio in March 2012. The team's function is to carry out management for NRW reduction mainly in the service area of Can Tho No. 1 WTP, and their duty is also to support other Water Companies. The team has four sub-teams, namely Distribution Network Management Team, Water Leakage Detection Team, Test Drilling Team, and Water Meter Management Team. The tasks and the number of staff of the four sub-teams are shown below.

1) Distribution Network Management Team

The Distribution Network Management Team consisting of 5 staffs compiles the GIS data of water pressure, location, material, length, and diameter of existing distribution network. The water pressure test is carried out in 70 measurement stations once a month.

2) Water Leakage Detection Team

The Water Leakage Detection Team consisting of 11 staffs carries out the detection of water leakage in land surface and underground with the use of the naked eye, acoustic bar, and electronic detector.

3) Test Drilling Team

The Test Drilling Team consisting of 5 staffs carries out the test drilling in the water leakage point detected by the Water Leakage Detection Team, and specifies the location. The Test Drilling Team then prepares a report and the leakage point is repaired by the Construction Team managed by WSSC headquarters office.

4) Water Meter Management Team

The Water Meter Management Team consisting of 4 staffs carries out the changing and calibration of water meter. The meter replacement interval is stipulated as five years in

Vietnamese regulation, however, the water meter is left unchanged over the regulated period. The Water Meter Management Team also inspects the illegal connection with the fare collection data. Most of the water meters are made in Italy while others are made in China and Taiwan.

3.1.3 Laws and Regulations Related to Water Supply BOT Business[1]

This section summarizes the relevant Vietnamese laws and regulations for BOT water supply projects. The list of the specific laws and regulations referred to in this section is provided in Appendix B2.1.

(1) Water Treatment Project and Water Tariff

1) Permission for Water Supply Services

To participate in the water supply business in Vietnam, one needs to obtain a permit for surface water abstraction in accordance with Decree No. 149/2004/ND-CP (Decree on the Issuance of Permits for Water Resource Exploration, Exploitation and Use, or for Discharge of Wastewater into Water Sources) and Decree No.117/2007/ND-CP (Decree on Clean Water Production, Supply, and Consumption). The surface water exploitation permit is issued by MONRE if the abstracted surface water is 50,000 m^3/day or more. In other cases, the permit is issued by the people's committee.

2) Price Setting of Water Tariff

In Vietnam, the minimum and maximum prices for water tariff are regulated as shown in Table 3.1.7

Table 3.1.7 Ranges of Water Tariff for Different City Category

Category	Minimum Price (VND/m^3)	Maximum Price (VND/m^3)
Urban areas of special cities or 1st category	3,500	18,000
Urban areas of 2nd, 3rd, 4th, and 5th category	3,000	15,000
Rural areas	2,000	11,000

Source: Circular No. 88/2012/TT-BTC Circular on the promulgation of clean water tariff framework

[1] Contents of this section are based on English-translated version of Vietnamese laws and regulations and information obtained through interviews with respective government authorities in Can Tho City.

Table 3.1.8 Categories of Urban Areas

Category	Population	Population Density (person/km^2)	Non-agricultural Labor Force
Special Cities	> 5 million	> 15,000	> 90%
1st Category	> 1 million* > 500,000**	> 12,000* > 10,000**	> 85%
2nd Category	> 800,000* > 300,000**	> 10,000* > 8,000 **	> 80%
3rd Category	> 150,000	> 6,000	>75%
4th Category	> 50,000	> 4,000	> 70%
5th Category	> 4,000	> 2,000	> 65%

Source: Decree No.42/2009/ND-CP Decree on the Grading of Urban Centers
* For cities under the authority of the central government
** For cities under the authority of the provincial government

The mechanism to determine the prices of water tariff is stipulated in the Joint Circular No.75/2012/TTLT-BTC-BXD-BNNPTNT (Joint Circular Guiding Principles and Method of Determination and Competence to Decide Water Consumption Price in the Urban Areas, Industrial Zones and Rural Areas).

Table 3.1.9 Calculation of Water Production Costs

The table is omitted due to confidentiality

Source: Joint Circular No.75/2012/TTLT-BTC-BXD-BNNPTNT (Joint Circular Guiding Principles and Method of Determination and Competence to Decide Water Consumption Price in the Urban Areas, Industrial Zones and Rural Areas)

The paragraph is omitted due to confidentiality.

The current price for each customer type in Can Tho City, as shown in the Table 3.1.10, was issued in August 2009.

Table 3.1.10 Water Tariff in Can Tho City

Type of Water Users		Unit Price (VND/m^3)
Domestic	Poor Households	3,500
	Residential Households	4,100
Institutions		5,000
Industry		5,800
Commercial		6,400

Source: Ref. No.2479/QĐ-UBND Decision on Clean Water Tariff applied in Can Tho City

The tariffs above were implemented in 2009, so a new set of tariffs will be enforced in 2013. (See Table 3.1.17 for the proposed amount of the new water tariffs.)

The paragraph is omitted due to confidentiality.

(2) Investment Regulations

1) Permission for Investment Project

The Common Investment Law (Law No. 59-2005-QH11) stipulates the procedures for investment registration for domestic and foreign investors. Those who want to start investment projects in Vietnam must obtain an investment certificate, which will be issued by the people's committee.

2) Business and Investment Registrations for Domestic Investment Projects

Investors establish a new enterprise through business registration in accordance with the Law on Enterprise (Law No. 60/2005/QH11, Article 15, 18, and 19). It is not a prerequisite for domestic investors to have investment projects when they establish a new enterprise. When domestic investors are going to start a project with an invested capital of VND 15 billion or more, the enterprise must complete the investment registration for domestic projects to obtain an investment certificate (Domestic investors are not required to perform the investment registration procedures for a project with an invested capital below VND 15 billion).

3) Business and Investment Registrations for Foreign Investment Projects

First time foreign investors in Vietnam must have an investment project and perform the necessary procedures for investment registration, so that foreign investment projects can obtain an investment certificate.

4) Evaluation of Investment Projects

When a project has invested a capital worth VND 300 billion or more, a project evaluation must be performed by the people's committee prior to the issuance of an investment certificate.

The paragraph is omitted due to confidentiality.

(3) Land Use Regulations

1) Permissions Required for Land Use

In Vietnam, foreign organizations can only rent the land necessary for a project (land assignment is not applicable).

The paragraph is omitted due to confidentiality.

2) Land-related Costs

Costs of compensation, support, and resettlement related to the acquisition of project land must be included in SPC's project investment capital in accordance with Decree 69/2009/ND-CP, Article 15.

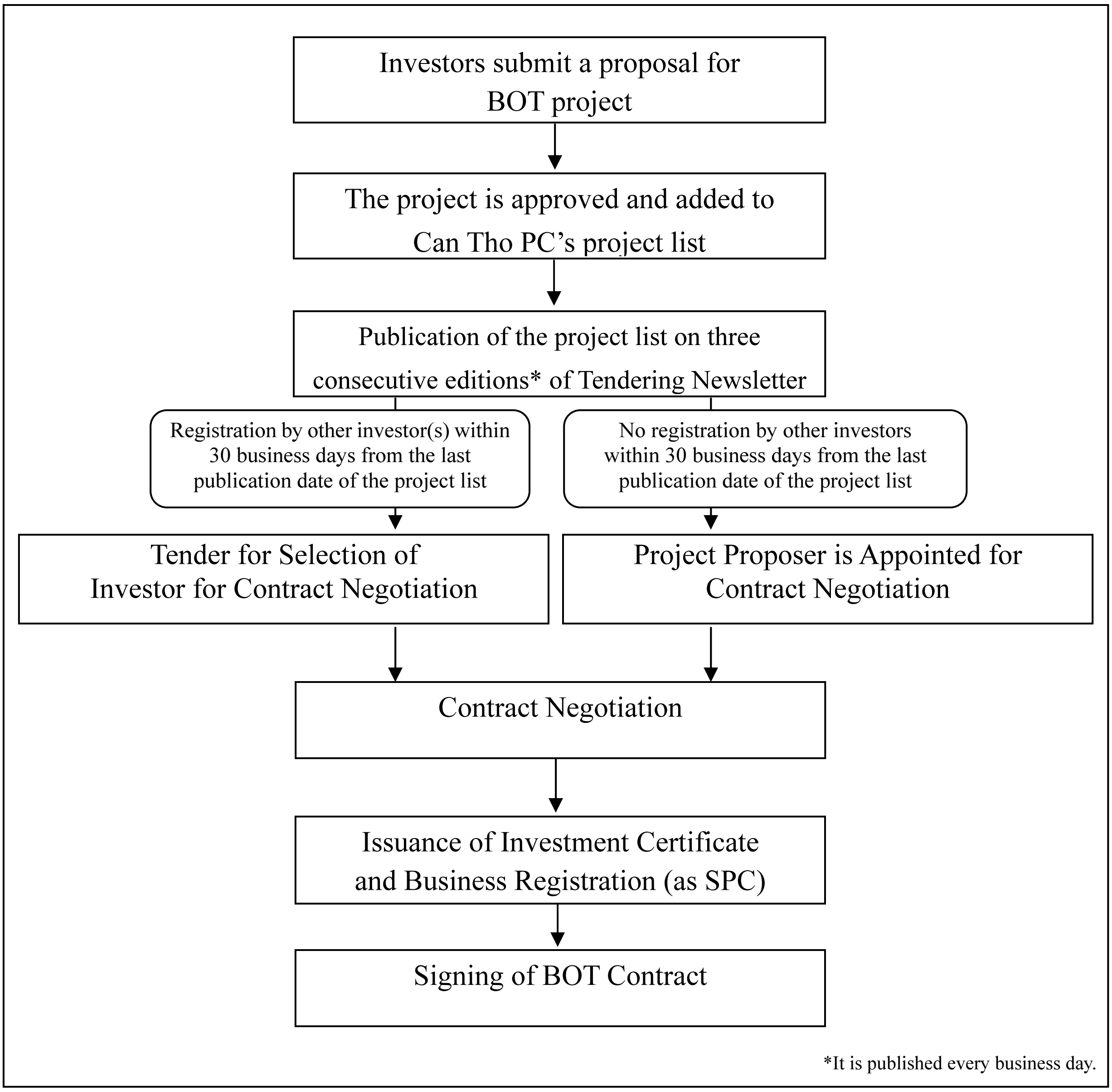
In case of BOT projects, SPC will be exempted from payment of land levies and land use rents for the project land in accordance with the provisions on incentives stipulated in the BOT Law (Decree 108, Article 38).

(4) BOT Regulations

1) Procedures for Approval of BOT Project and Selection of Contractor

The BOT projects in Vietnam are implemented in accordance with Decree 108/2009/ND-CP (Decree on Investment in the Form of Build-Operate-Transfer, Build-Transfer-Operate, or Build-Transfer Contract), or also known as "the BOT Law". Some of its articles have been amended by Decree 24/2011/ND-CPg. These laws stipulate the procedures and conditions for investors who would like to participate in BOT business in Vietnam.

The development procedures for a BOT project which involves investor's project proposal are outlined in Figure 3.1.5.



Source: JICA Study Team

Figure 3.1.5 Procedures on Project Development for BOT Scheme

2) Project Proposal

Article 12, Clause 2 of the BOT Law prescribes the following contents required for the project proposal:

- Analysis of the necessity and advantages of implementing the project in the form of a BOT contract as compared with other investment forms;
- Contents of the services which will be provided through operation of the facility, as well as fees and charges for those services;
- Duration for the construction and operational period for the project, as well as the methods of management and operation of the facility;
- Conditions and method of facility turnover at the end of the operational period; and
- Proposals on applying forms of investment incentives, support, and guarantees from the government.

If the proposed project is not included in the city’s master plan, the people's committee shall consider amending the master plan to include it.

3) F/S Report

The list of the information required to be included in the F/S report is provided in Appendix B2.3. In case the project is categorized as a “national important project” (See Appendix B2.4 for definition), the F/S report will require approval from the Prime Minister.

4) Capital Sources of the Project

In case the project’s total investment capital is worth up to VND 1.3 trillion, the equity of the project enterprise must not be lower than 15% of the total investment capital of such project. Moreover, in case the project’s total investment capital exceeds VND 1.5 trillion, the required equity of the project enterprise shall not be lower than the total of (a) and (b) below:

(a) With respect to that portion of investment capital worth up to VND 1.5 trillion, 15% of such portion;
(b) With respect to that portion of investment capital exceeding VND 1.5 trillion, 10% of such portion.

The state-owned capital included in a project shall not exceed 49% of the total investment capital of such project. This includes not only the equities for the SPC but also any costs including subsidies and goods investment spent by the government.

5) Costs of Project Development

Preparation costs for BOT projects, such as formulating and announcing the project list and selecting investors, are paid by the state budget. However, the investor selected to implement the project must pay the authorized state body the costs of formulating and evaluating the F/S report of the project.

6) Security for Obligation to Perform Project Contract

The amount of the security deposit for the obligation to implement the project contract must not be less than 2% of the total investment capital in the case where project's total investment capital is worth up to VND 1.5 trillion. However, in case the project's total investment capital is above VND 1.5 trillion, the amount of the deposit must not be lower than the total of (a) and (b) below:

(a) With respect to that portion of investment capital up to VND 1.5 trillion, 2% of such portion;
(b) With respect to that portion of investment capital exceeding VND 1.5 trillion, 1% of such portion.

7) Selection of Subcontractors

According to MPI, DPI, and the BOT Law, the selection of EPC contractors must be performed in accordance with the Law on Tendering (Law No. 61/2005/QH11). If the law is applicable to this project, then an EPC contractor must be selected through open bidding.

The paragraph is omitted due to confidentiality.

8) Transfer of Project Facility

Upon expiry of the commercial operation of the project facility, the investor shall turn over the facility to the authorized state body without compensation. The procedures and conditions for turnover of the facility are provided in Article 36 of the BOT Law as follows:

- One year before the transfer will take place or within the time limit agreed in the project contract, the SPC publishes a notice about the handover of the facility and issues relevant procedures for liquidation of contracts and for discharge of debts;
- The authorized state body shall organize a verification of the quality, value, and status of the facility in accordance with the agreements in the project contract, and shall prepare a list of assets to be handed over, identify loss and damage (if any), and require the SPC to undertake repairs and maintenance of the facility;
- The investors and the SPC must ensure that the assets will not be used to provide a guarantee for discharge of financial obligations or will not be mortgaged or pledged as security for other obligations of the investor or the SPC arising before the time of transfer, unless the project contract contains some other provision;
- The SPC shall be responsible for technology transfer, training, provision of periodical maintenance, and general overhaul in order to ensure the technical conditions for normal operation of the facility, consistent with the requirements in the project contract; and
- After the facility has been turned over, the authorized state body shall organize the management and operation of the facility.

9) Incentives for BOT Projects

In order to obtain incentives, such as exemption from or reduction of tax and other obligations, investors must request for these at the time of application for the investment certificate and be approved by respective authorities. Details of approved incentives will be written on the investment certificate. The BOT Law as well as other related laws provide some incentives applicable to both domestic and foreign investors. For the tax-related incentives, see Item (5) Tax Regulations below for details.

The paragraph is omitted due to confidentiality.

(5) Tax Regulations

1) Incentives Provided in the Enterprise Income Tax Law

The regular rate of enterprise income tax in Vietnam is set at 25%.

According to Decree 124/2008/NC-DP (Decree Detailing and Guiding the Implementation of a Number of Articles of the Law on the Enterprise Income Tax), the incentive tax rate and reduction rate as shown in Table 3.1.11 will be applied for new enterprises, which are established under investment projects in certain domains including the development of water treatment plants, during their operational period.

Table 3.1.11 Incentive Mechanism of Enterprise Income Tax

Incentive tax rate	10% for the first 15 years of operation	
Reduction rate to the incentive tax rate	100% for the first 4 years of operation 50% for subsequent 9 years of operation	
Payable tax amount for each operational year	1st~4th year	**0%**
	5th ~9th year	**5%**
	10th ~15th year	**10%**
	16th year and after	**25%**

Source: Decree No.124/2008/NC-DP (Detailing and guiding the implementation of a number of articles of the law on enterprise income tax)

2) Incentives Provided in the Common Investment Law

The Common Investment Law stipulates tax incentives for investment incentive sectors[2]. According to DPI, water supply business is considered as one of these sectors and thus, investors can apply for the following incentives:

- Tax incentives on income, which are distributed to investors according to their capital contribution or purchase of shareholding in the SPC, after the SPC has paid the full enterprise income tax;
- Exemption from payment of import duty on equipment, materials, means of transportation, and other goods necessary for the implementation of projects in Vietnam; and
- If an investor suffers losses after the calculation of income tax for a fiscal year, it shall be permitted to carry its losses forward to the subsequent fiscal years, and the amount of such losses shall be set off against the taxable income of each year. The period for carrying forward losses shall not exceed five years.

The Common Investment Law also provides a non-tax incentive for the projects in

[2] Specific sectors applicable to the incentives stipulated in the Common Investment Law. It includes construction and development of infrastructure facilities, as well as other business sectors such as high-tech products, bio-technologies,

investment incentive sectors that can accelerate the depreciation of fixed assets. The maximum rate of depreciation shall not be more than twice the level of depreciation as stipulated by the regulations on depreciation of fixed assets.

3) Incentives Provided in BOT Law

The BOT Law provides that goods imported to implement projects of BOT enterprises and contractors shall enjoy the incentives stipulated in the Law on Import Tax and Export Tax. The Law No. 45/2005/QH11 (Law on Import Tax and Export Tax) provides that goods imported to create fixed assets of projects entitled to investment incentives shall be exempted from import duties (correlated with the above provision of the Common Investment Law).

education, environmental protection, and traditional industries.

3.1.4 Financial Status of WSSC and Relevant Organizations.

(1) Corporate Profile

1) Business

The WSSC provides not only water production and sales services, but also several different types of services, which include the following:

(a) Production and sales of clean water;

(b) Sewerage service and waste water treatment;

(c) Construction of civil works, specialized water supply works at the capacity of 20,000 m^3/day and infrastructure engineering works;

(d) Construction of aqueduct:

(e) Backfilling;

(f) Road mending;

(g) Production and trade of water supply and sewerage equipment and materials;

(h) Consultancy, design and supervision for water supply and sewerage works and civil industry;

(i) Production and sales of potable drinking water; and

(j) Consultancy, engineering construction surveys, and water supply and sewerage works planning.

2) Structure

The paragraph is omitted due to confidentiality.

The figure is omitted due to confidentiality.

Source: WSSC

Figure 3.1.6 Organizational Chart of WSSC Group

3) History

The WSSC has started its history in1932. After the foundation of Can Tho City in 1970, the Can Tho PC developed the No. 1 WTP (Lot 1) in1973 and handed over to WSSC in 1975.

1973 Construction of Can Tho No. 1 WTP (Lot 1)

1975 Privatization of parts of state agency into WSSC

1998 Construction of Can Tho No. 2 WTP (Lot 1)

1998 Construction of Can Tho No. 2 WTP (Lot 2)

2002 Construction of Tra Noc WTP WTP (Lot 1)

2004 Construction of Can Tho No.1 WTP (Lot 2)

2004 Construction of Tra Noc WTP (Lot 1)

2004 Construction of Tra Noc WTP (Lot 2)

2006 Construction of Hung Phu WTP

The paragraph is omitted due to confidentiality.

(2) Financial Status

1) Profit and loss (P/L) statement

The paragraph is omitted due to confidentiality.

Table 3.1.12 Profit and Loss Statement of WSSC

The table is omitted due to confidentiality.

Source: JICA Study Team

Table 3.1.13 Water Sales Amount in 2011

NO	WATER TREATMENT PLANT	Domestic(m3)		Institutions (m3)	Industry (m3)	Commercial (m3)	Total (m3)
		Poor households	Residential households				
1	WTP No. 1 Branch	49,559	6,831,935	1,502,313	227,240	2,391,665	11,002,712
2	WTP No. 2 Branch	13,305	4,927,646	971,217	472,767	1,562,755	7,947,690
3	An Binh Branch	2,699	2,226,119	440,766	97,029	354,646	3,121,259
4	Binh Thuy Branch	9,173	1,079,997	154,948	14,478	307,452	1,566,048
5	Hung Phu Branch	1,120	692,689	81,405	86,159	104,140	965,513
6	Vinh Thanh	14,622	269,660	60,319	5,921	64,182	414,704
7	Long Hoa J.S. Company	2,843	297,902	40,075	2,057	33,344	376,221
8	Tra Noc J.S. Company	7,922	595,114	26,019	1,985,486	207,753	2,822,294
9	O Mon J.S. Company	21,867	613,931	91,249	32,389	111,025	870,461
10	Thot Not J.S. Company	13,847	1,192,817	147,580	54,174	387,582	1,796,000
TOTAL		136,957	18,727,810	3,515,891	2,977,700	5,524,544	30,882,902

Source: WSSC

2) Cash flow statement

Table 3.1.14 illustrates the cash flow statements of WSSC in the recent from 2009 to 2011.

The paragraph is omitted due to confidentiality.

Table 3.1.14 Cash Flow Statement of WSSC

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

Source: JICA Study Team

3) Balance sheet

Table 3.1.15 was calculated based on Table 3.1.14.

Table 3.1.15 Financial Index of WSSC

The table is omitted due to confidentiality.

Source: JICA Study Team

Table 3.1.16 Balance Sheet of WSSC

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

Source: JICA Study Team

(3) New Tariff Application

The paragraph is omitted due to confidentiality.

Table 3.1.17 Financial Index of WSSC

The table is omitted due to confidentiality.

Source: No. 165/STC-QLG-CS Proposal for Adjustment of Clean Water Tariff applied in Can Tho City (January 24th, 2013)

3.2 Existing Water Supply Facilities

3.2.1 Existing Water Treatment Plant

The WSSC is currently managing 13 WTPs in Can Tho City, including Can Tho No.1 and No. 2, Tra Noc, Thot Not, and Hung Phu with a total plant capacity of 135,000 m^3/day.

The WSSC also manages eight WTPs in rural areas with capacities of 480-5,000 m^3/day. The total capacity in the rural area is 18,920 m^3/day. The details are shown in Table 3.2.1.

(1) Can Tho No. 1 WTP

Can Tho No. 1 WTP has three sub-units consisting of intake pumps, sedimentation tanks, filter, and distribution pumps. The production capacities of the three sub-units are 30,000m^3/day, 20,000m^3/day, and 5,000m^3/day, respectively. There are two intake pumping stations, one is for the first unit and the other is for the second unit. Each station has three vertical shaft pumps. The third unit has three submersible pumps that are installed under the second pumping station. Two raw water pipelines, 600 mm diameter each, connect two pumping stations and the eceiving well. The coagulant PAC is dosed at this well and rapid mixing has taken place through dynamic energy of falling water. The coagulated raw water splits at the well and flows by gravity to the sedimentation tanks. Raw water for the third unit is transmitted to the plant via the 200 mm-diameter pipeline. A static mixer has been installed at the end of pipeline, and the coagulant is dosed just upstream of the mixer. Rapid mixing is being carried out by this mixer.

The first unit consists of two sedimentation tanks and one filter. The sedimentation tanks is a vertical up flow type called as the “acceletor”, and the filter is a self-washing type. The second unit also has two sedimentation tanks and one filter. The sedimentation tanks are the same with the first unit. The filter is a rapid gravity sand filter called as the “aquazur filter”. The third unit consists of two sedimentation tanks and eight pressurized filters. They are all made of steel. Disinfection is being carried out on the filtered water at the effluent by chlorine.

The treated water from these sub-units enters into five clear water reservoirs and two pump suction tanks by gravity. These reservoirs and tanks are connected with pipes. There is an elevated tank, with a capacity of 2000 m^3, but is not currently being used. The total storage capacity of the reservoirs is 15,700 m^3, excluding the capacity of the elevated tank, and the retention is about 6.9 hours. There are two distribution pump stations. Each station has three distribution pumps, and their delivery head is 0.15 MPa.

Sludge from the sedimentation tanks and backwash wastewater from the filters enter into a sludge pond by gravity flow. In the pond, the supernatant is formed by a separation. The supernatant is returned to the river and the sludge is being removed periodically from the pond and disposed to a dump site of WSSC by tanker trucks.

The quality of the treated water has met the drinking water standards of Vietnam in all the test items. However, it is recommendable that the plant should be operated considering the following:

i) Turbidity of settled water seems slightly higher, since the dosing rate of PAC is insufficient;

ii) Backwash interval of filters is one day. It is usually two to three days where flocculation is properly carried out with sufficient coagulant dosage and sedimentation tank is properly functioning;

iii) Sludge scraper in the acceletor was not in operation when the JICA Study Team visited the plant. It should not be stopped unless otherwise required for the maintenance and repair because the scraper has an important role to collect and drain sludge from the tank properly and sufficiently. A scraper that has been stopped for a long time could cause damaged due to overloading by accumulated sludge.

iv) According to the operator, sludge in the pond is periodically removed and dumped to a disposal site by tanker trucks. However, it does not conform to the technical estimation. Estimated daily sludge productions during dry and wet seasons are about 150 m^3/day and 450 m^3/day, respectively. It seems unrealistic to convey and dispose such large volume on a daily basis, and no evidence of such work was found in the site survey.

v) Algae growth was found on the settling plates in the steel sedimentation tanks. It disturbs removal of sludge from the inclined plates. Therefore, more frequent pre-chlorination should be carried out.

Table 3.2.1 Summary of the Existing Water Treatment Plants

No.	Name	Design Capacity ($\times$1000m^3/day)	Current Production ($\times$1000m^3/day)	Location (District)	Water Source	Intake Pump Spec./Qty	Water Treatment System	Distribution Spec./Qty	Sludge Treatment Method	Commissioned Year
1	Can Tho No.1	55	60	Ninh Kieu	Can Tho River	Vertical Shaft 650 m^3/h*45kW*3 900 m^3/h*55kW*3 Submerged 120 m^3/h*11kW*3	HM+AC+CGF HM+AC+CGF PS+PF	Vertical Shaft 850 m^3/h*132kW*3 850 m^3/h*160kW*2 400 m^3/h*100kW*1	Sludge Pond	1973/2004/2011
2	Can Tho No.2	42.5	47	Binh Thuy	Hau River/Khai Luong Canal	Vertical Shaft 950 m^3/h*75kW*3 840 m^3/h*55kW*2	HM+PU+AF PS+PF	Vertical Shaft 840 m^3/h*132kW*1 840 m^3/h*200kW*2	Sludge Pond	1998/2010
3	Tra Noc	20	10.1	O Mon	Hau River	Vertical Shaft 480 m^3/h*37kW*2 450 m^3/h*37kW*1	HM+PU+AF	Vertical Shaft 600 m^3/h*110kW*1 600 m^3/h*110-126.5kW*2	Lagoon	2004/2011
4	Hung Phu	10	4	Cai Rang	Hau River	Vertical Shaft 450 m^3/h*37kW*2	HM+PU+AF	Vertical Shaft 600 m^3/h*110kW*2	Lagoon	2005
5	Thot Not	7.5	7.1	Thot Not	Hau River	Submerged 110 m^3/h*11kW*2 210 m^3/h*11.5kW*2 Centrifugal 180 m^3/h*22.5kW*1	HM+SB+AF TS+PF	Vertical Shaft Centrifugal 120 m^3/h*22kW*1 72－165 m^3/h*22kW*4	Sludge Pond	2005/2009
6	Long Hoa	2	1.9	Binh Thuy	Cam Canal	Centrifugal 54－132 m^3/h*7.5kW*2	PS+PF	Centrifugal 54－144 m^3/h*22.5kW*2	N/A	2010
7	Ba Lang	5	4	Cai Rang	Can Tho River	Submerged 390 m^3/h*11kW*2	PS+PF	Centrifugal 208 m^3/h*22kW*2 50－120 m^3/h*22kW*1 54－144 m^3/h*22.5kW*1	Sludge Pond	2009/2011
8	Vinh Thanh	3.22	0.5	Vinh Thanh	Cai San Canal	Centrifugal 10 - 28.8 m^3/h*2.2kW*1 9 - 42 m^3/h*7.5kW*2 Submerged 18－252 m^3/h*13.6kW*2	TS+PF SB+GF	Centrifugal 10－36 m^3/h*4kW*1 40 m^3/h*5.5kW*1 54－144 m3/h*22.5kW*2	N/A	2003/2008
9	Thanh An	0.72	1	Vinh Thanh	Cai San Canal	Submerged 3－120 m^3/h*7.5kW*2	PS+GF SB+GF	Centrifugal 21－78 m^3/h*7.5kW*2 12－42 m^3/h*3.0kW*1	Sludge Pond	1999
10	O Mon	2.4	2.4	O Mon	O Mon River	Centrifugal 250 m^3/h*30kW*1 180 m^3/h*18.5kW*1	PS+GF	Centrifugal 150 m^3/h*30kW*1 110 m^3/h*11kW*1	N/A	
11	Thoi Lai	2.5	0.5	Thoi Lai	O Mon River	Centrifugal 180 m^3/h*7.5kW*1 200 m^3/h*11kW*1	HM+SB+AF	Centrifugal 60 m^3/h*11kW*2 180 m^3/h*18.5kW*1	Sludge Pond	2006
12	Co Do	4.8	0.7	Co Do	Groundwater	Well Pump*3	PF	Centrifuga*2	N/A	
13	Bong Vang	2.5	1.8	Phong Dien	My Khanh River	Submerged 110 m^3/h*11kW*2	PS+PF	Centrifugal 110 m^3/h*22.5kW*2	Sludge Pond Under Construction	2012

Source: JICA Study Team

Note: HM: Hydraulic Mixing, MM: Mechanical Mixing, AC: Accelator, PU: Pulsator, SB: Slurry Blanket, PS: Steel tank with plate settler, TS: Steel tank with tube settler, CG: Conventional Gravity Filter, AF: Aquazur Filter, GLF: Green leaf Filter, PF: Pressurized Filter

(2) Can Tho No. 2 WTP

The Can Tho No. 2 WTP has two sub-units while an additional unit is currently under construction. The production capacities of the sub-units are 40,000 m^3/day, 2,500 m^3/day, and 10,000 m^3/day, respectively. There are three intake pumping stations. The first pumping station is situated in the Con Khuong Island. Two vertical shaft water pumps abstract raw water from the main stream of Hau River and transmit to a receiving well in the plant via the 600 mm-diameter pipeline. The second pumping station is situated in the Khai Luon Canal that crosses between the WTP and the island. Three vertical shaft pumps abstract raw water and transmit to the receiving well. Two submersible pumps are installed in the second intake pumping station to transmit to the 2500 m^3/day sub-unit. The additional sub-unit is proposed in the same canal and transmits to the sub-unit of 10,000 m^3/day.

The receiving well for the 40,000 m^3/day sub-unit has two weirs over which the raw water splits to sedimentation tanks. The coagulant PAC is dosed at the weirs and rapid mixing takes place by using falling water energy from the weirs. This unit consists of four sedimentation tanks, up flow type, called as the pulsator, and two aquazur filters. The 2500 m^3/day sub-unit is a package type made of steel, which uses sedimentation tank with inclined plates, and pressurized filters. The new 10,000 m^3/day sub-unit consists of a sedimentation tank with tube settling, an aquazur filter, and a clear water reservoir.

Treated water from these units flows into clear water reservoirs by gravity. Disinfection by chlorine is carried out at the inlet, and distributed to the city area by six distribution pumps.

Sludge from the sedimentation tanks and backwash wastewater from the filters are discharged to the canal via a sludge lagoon which is located next to the existing WTP site. No sludge treatment has been carried out.

Treated water quality of this WTP has met the drinking water standards of Vietnam in all test items. However, there are some advisable findings regarding the facilities and the operations. They are summarized as follows:

i) Turbidity after settling is still very high. To identify the cause, the JICA Study Team conducted a jar test. It was found that PAC dosing rate is insufficient. Details of the jar test result are presented in Appendix B3;

ii) Backwash interval is one day, the same comment as of Can Tho No. 1; and

iii) Sludge treatment is not properly carried out.

(3) Tra Noc WTP

The Tra Noc WTP consists of two sub-units with a total production capacity of 20,000 m^3/day. A pumping station is situated in the Hau River. Three vertical shaft intake pumps abstract raw water from the Hau River and transmit it to the receiving well. The receiving well has a weir where the coagulant PAC is dosed. Rapid mixing is carried out using falling water energy from the weir. The coagulated raw water enters into two pulsators, and the settled water goes to an aquazur filter. The filtered water is then disinfected by chlorine and conveyed to clear water reservoirs. All flows are conveyed by gravity.

The pulsators periodically drain sludge from the bottom which then goes to a regulating tank. Backwash wastewater of the filter also flows to this regulating tank where sludge and wastewater decantation take place. The supernatant is conveyed back to the river by gravity and the sludge is sent to two sludge lagoons that are situated within the plant premises. Sludge removal from the lagoons is carried out with the same manner as explained in Can Tho No.1 WTP.

Treated water quality from the Tra Noc WTP has met the drinking water standards of Vietnam in all the test items. However, the plant has advised the following items:

i) Turbidity of water after settling is high, the reason is the same as explained in Can Tho No. 2 WTP;

ii) Vacuum pumps of the pulsator were not being operated when JICA Study Team visited the plant. The vacuume pumps generate pulsation of water in the tank and the pulsation is important for good flocculation. The performance of the pulsator is largely governed by floc size. Stopping the vacuum pump clogs the defusing pipes in the tank by accumulated sludge. To recover the clogging, the tank must be completely drained and cleaned up; and

iii) It is believed that sludge treatment is not properly done, the reason is the same as explained in Can Tho No. 1 WTP.

(4) Hung Phu WTP

This plant uses completely the same system as the Tra Noc Plant, the only difference is its treating capacity of 10,000 m^3/day. The operation status, performance, and problems encountered are also the same with Tra Noc WTP.

(5) Thot Not WTP

The plant consists of two sub-units, with capacities of 5000 m^3/day and 2500 m^3/day. The first sub-unit uses a sludge blanket type sedimentation tank and aquazur filter. The second sub-unit is a package type. The sedimentation tank installed has tube settling, while the filter is a pressurized type, both of which are made of steel. The treated water from these sub-units flows to the clear water reservoir by gravity, and is distributed to the city area by pumps.

There are two sludge lagoons that receive sludge from the sedimentation tanks and backwash wastewater from the filter. The supernatant is returned to the river by gravity, while the sludge is removed in the same manner as explained in the Can Tho No. 1 WTP. PAC and chlorine are used for water treatment.

Treated water quality of this WTP has met the drinking water standards of Vietnam in all the test items. However, the plant has the following challenges:

i) The upper end of the tube settling in the package sedimentation tank has been exposed. Since water cannot flow through the tube settling, it makes the efficiency low. Therefore, the tube settling should be rearranged so that the top of all tube settlings is submerged in water; and

ii) Most of the sludge in the lagoon returns to the river without sufficient treatment.

(6) Treated Water Quality of Existing WTPs

Treated water quality of existing WTPs have cleared all items in the drinking water standards of Vietnam.

Treated water quality of four large plants is summarized in Table 3.2.2.

Table 3.2.2 Summary of Treated Water Quality

					Can Tho 1 WTP			Can Tho 2 WTP			Tra Noc WTP			Hung Pho WTP		
	Item		Unit	Allowable limit	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
1	Color		mg/l Pt	15	1	6.3	10	1	7.1	12	1	5.3	10	2	6.8	15
2	Odour				-	-	-	-	-	-	-	-	-	-	-	-
3	Turbidity		NTU	2	0.15	0.5	0.9	0.17	0.2	0.25	0.24	0.4	0.5	0.23	0.6	1.8
4	pH		mg/l	6.5-8.5	7	7.0	7.1	6.9	7.0	7.1	6.7	6.9	7	6.8	7.0	7.1
5	Hardness		mg/l	300	52	59.3	66	50	56.8	65	50	57.8	66	50	55.8	60
6	Crome	(Fe)	mg/l	0.3	0.01	0.0	0.04	0.01	0.0	0.03	0.01	0.0	0.02	0.01	0.0	0.08
7	Chromium	(CrVI)	mg/l	0.05	0	0.0	0.01	0	0.0	0.01	0	0.0	0.01	0	0.0	0
8	Chloride	(Cl^-)	mg/l	250	18	21.9	26	18	21.1	26	18	21.6	26	18	21.2	26
9	Nitrate	($N\text{-}NO_3^-$)	mg/l	50	0	0.1	0.8	0	0.3	0.8	0	0.2	0.7	0	0.1	0.4
10	Nitrite	($N\text{-}NO_2^-$)	mg/l	3	0.001	0.0	0.09	0.006	0.0	0.02	0.007	0.0	0.012	0.001	0.0	0.02
11	Residual Chlorine		mg/l	0.3-0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.3	0.4	0.5
12	Sulfide	(SO_4^{2-})	mg/l	250	1	5.0	15	1	4.8	11	1	5.2	11	1	6.3	15
13	Manganese	(Mn)	mg/l	0.3	0.1	0.1	0.2	0.1	0.2	0.2	0	0.2	0.3	0.01	0.1	0.2
14	Ammonia	($NH4^+$)	mg/l	3	0	0.0	0.1	0	0.1	0.2	0	0.1	0.13	0	0.0	0.1

Source: JICA Study Team

3.2.2 Distribution Facilities

(1) Present Condition of Existing Distribution Pipelines

Summary of existing distribution pipes managed by WSSC in the urban area is shown in Table 3.2.1. The detailed information is described in Appendix B4. Almost 95% of the distribution pipes are installed in the water supply areas of Can Tho Nos.1 and 2 WTPs. Distribution pipes of diameter (DM) 250 mm or less are made of polyvinyl chloride (PVC) and ductile cast iron (DCI). Large pipes of above DM 250 mm are made of DCI. Total length of existing distribution pipes is approximately 500 km, and the diameter ranges from 34 mm to 700 mm.

Table 3.2.3 Summary of the Existing Distribution Pipes in the Urban Area Managed by WSSC

Diameter (DM, mm)	Total Length (m)	Material
Less than 150 (34～114)	302,475	PVC
	6,220	DCI
150	71,690	PVC
	2,157	DCI
200	45,909	PVC
	8,777	DCI
250	4,515	PVC
	19,347	DCI
300	9,209	DCI
314	4,135	PVC
375	4,621	DCI
400	6,341	DCI
600	13,886	DCI
700	500	DCI
Total	499,782	PVC, DCI

Source WSSC

The installation year of distribution pipes of above DM 300 mm is shown in Table 3.2.2. Over 70% of the distribution pipes of above DM 300 mm were installed in the past 15 years.

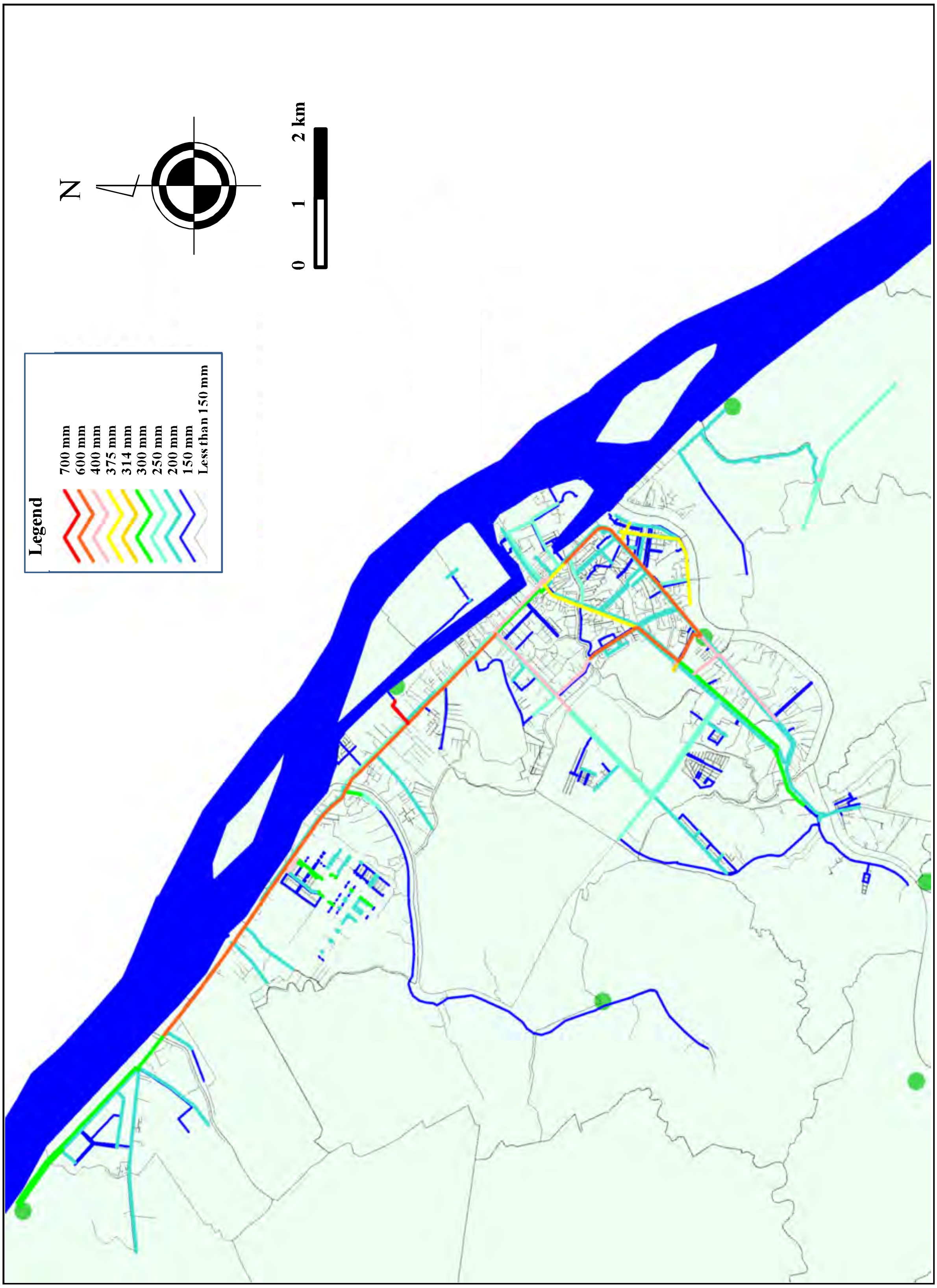
Table 3.2.4 Installation Year of Distribution Pipes of over DM 300 mm

Installation Year	%
Under 5	11
5-10	18
11-15	45
Over 15	26

Source: WSSC

There is no data of installation year of distribution pipes of under DM 300 mm. However, the pipes of under DM 300 mm are mainly PVC pipes, and it indicates that pipes were installed in the past 20 years, because PVC has become a common material for distribution pipes since the 1990s in Vietnam.

The overall view of the existing distribution pipes managed by WSSC is shown in Figure 3.2.1. The distribution pipes are installed densely in the center of the urban area.



Source: WSSC

Figure 3.2.1. Existing Distribution Pipelines in the Urban Area Managed by WSSC

(2) Other Facilities

1) Distribution Reservoir

There are three large elevated tanks in the urban district as follows:

- Elevated tank with a capacity of 2250 m^3 in Can Tho No.1 WTP service area
- Elevated tank with a capacity of 500 m^3 in the premise of WSSC Head Office
- Elevated tank with a capacity of 300 m^3 in Tra Noc Industrial Zone

However, these tanks are not currently used. In the urban district, the water is distributed directly by the distribution pumps.

2) Pressure Measurement Facility

There are 70 pressure measurement points that are installed on the distribution pipes in the water supply areas of Can Tho No.1 and 2 WTPs. Water pressure check has been carried out by the NRW reduction team of WSSC once a month to detect the water leakage point. The result of the water pressure measurements is shown in Figure 3.2.2. The water pressure was below the Vietnamese Standard of 1.0 kgf/cm^2 (0.098MPa) in all measurement points, and below 0.2 kgf/cm^2(0.020MPa) in remote area from WTPs. This is caused by the water leakage, low water head of distribution pump. NRW reduction team is carrying out the water leakage check.

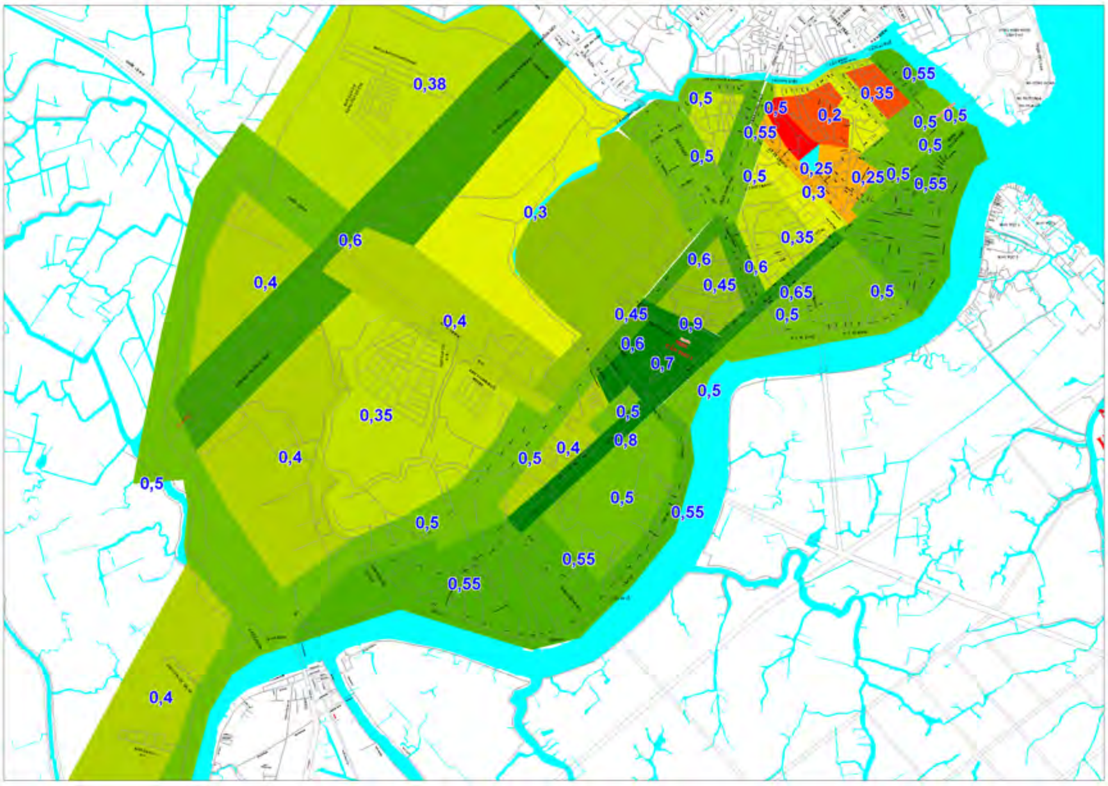
Based on the pressure measurement result, WSSC plans to improve the water pressure situation by increasing the distribution pumps in Can Tho Nos.1 and 2 WTPs. The current minimum water pressure at WTP is 0.2 kgf/cm^2 (0.020MPa). WSSC plans to increase the water pressure up to 0.5 kgf/cm^2 (0.049MPa) until 2015, and 1.0 kgf/cm^2 (0.098MPa) until 2020.

3) Fire hydrants

There are 326 fire hydrants that are installed on the distribution pipelines managed by WSSC. The fire hydrants are inspected twice a year, and the location o is recorded in GIS data. Due to the lack of water pressure in the distribution pipelines, fire trucks use booster pumps.

4) Valve

There are 345 valves that are installed on the distribution pipelines managed by WSSC. The valves are inspected twice a year, and the location is recorded in GIS data. The valves are used for interruption of water flown at the time of an accident, and division of water supply area of Can Tho No.1 and No.2 WTP.



Note: Unit of water pressure is kgf/cm^2 on this figure.

Figure 3.2.2. Result of the Water Pressure Measurements

3.2.3 Major Problems on Water Supply Facilities

(1) Insufficient Capacity of WTP

There are a lot of problem for operation and maintenance in WTPs such as injection amount shortage of coagulation agent, unfixed and non operating sedimentation pond, and evacuation of non treated sludge.

(2) Water Leakage

According to the report by the NRW reduction team of WSSC, water leakage in the existing distribution pipes occur especially in small PVC pipes. It would be caused by inadequate pipe construction. In NRW reduction team, there is no sufficient number of staff and equipment.

(3) Insufficient Water Pressure of Distribution Pump in WTP

In the distribution network managed by WSSC, the water pressure is very low due to the insufficient water pressure of distribution pump in Can Tho No.1 and No.2 WTP.

CHAPTER 4 PLAN OF FUTURE WATER SUPPLY SYSTEM

4.1 Basic Framework for Future Water Supply System

The basic framework for the future water supply system in Can Tho City is summarized as follows:

i) The target year for the future water supply system in Can Tho City was set at 2020;

ii) The future water supply plan was basically formulated in accordance with the Can Tho City Master Plan 2030. However, the detailed water demand for each ward or commune was not projected in the said master plan. The Study Team carried out the projection for each ward or commune to identify the future water deficit covered by each water treatment plant in 2020;

iii) A partial new water supply area for the target year 2020 was proposed by DOC, DARD, and WSSC in 2012;

iv) The target area for the priority project was selected in urban areas, particularly from the distribution areas of Can Tho No. 1 and No. 2 WTPs; and

v) Hau River was selected as the water source of the proposed WTPs in consideration of the water quality. The salt water intrusion problems were assessed and found to be not a critical issue.

4.2 Related Plans and Projects

4.2.1 Can Tho City Master Plan 2030

The Can Tho City Master Plan 2030 was approved by Can Tho PC in the second half of FY 2012. Five new WTPs and some extention works were proposed in the master plan as shown in Table 4.2.1 and Figure 4.2.1.

According to the review of the Study Team, some problems regarding the water demand projection and setting of water supply area were identified. The future population projection and development plan of IZs in Can Tho City were excessively projected in comparison with the current economic condition and its future growth. Subsequently, the future water demand proposed in the master plan was overestimated. In addition, the future distribution area and supply amount of each WTP were not indicated in the master plan.

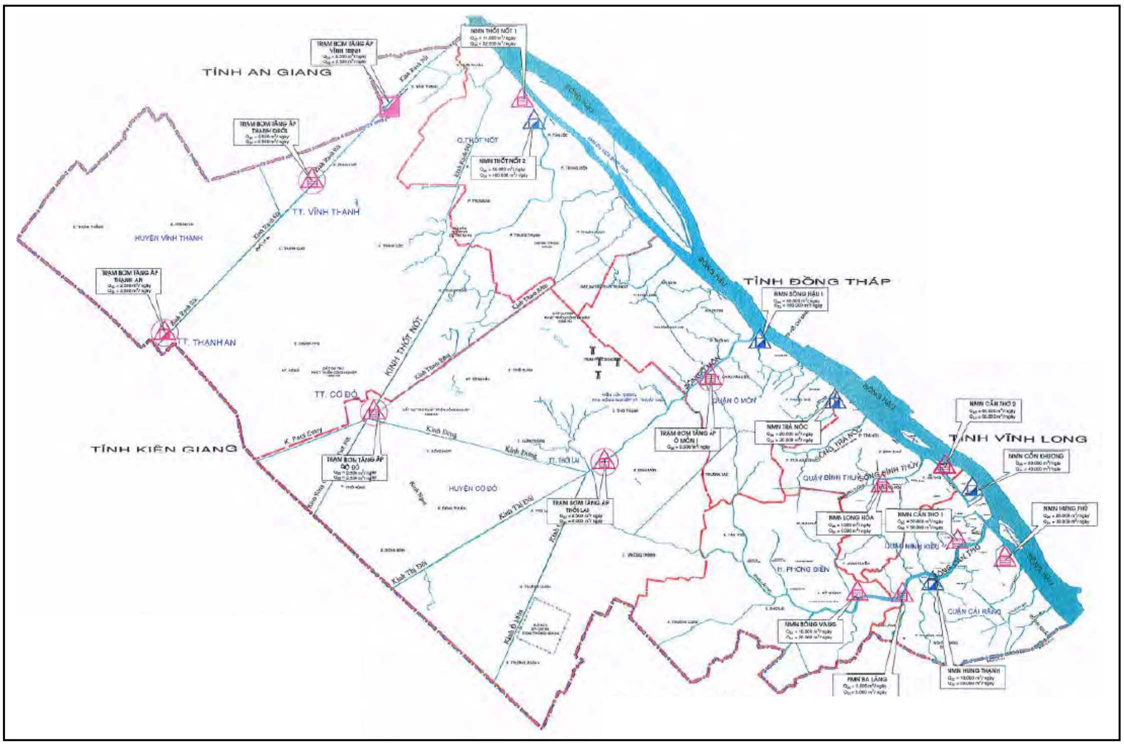
Table 4.2.1 Summary of Can Tho City Master Plan 2030

Item	Contents
(1) Target Year	Phase I (2020), Phase II (2030)
(2) Population Forecast	1.04 million (2020), 1.5 million (2030)
(3) Water Demand	302,788 m^3/d in 2020 =204,368 (urban) + 58,520 (rural) +39,900 (IZ) 485,664 m^3/d in 2030 =354,911 (urban) + 73,150 (rural) +57,603 (IZ)
(4) Development Plan of the WTP	(see table below)

No.	WTP	Design Capacity for 2020 (m^3/day)	Design Capacity for 2030 (m^3/day)	Water Source (River and Canal)	Notes
1	Can Tho 1	50,000	50,000	Can Tho	
2	Can Tho 2	50,000	60,000	Hau	Extension
3	Con Khuong	30,000	40,000	Hau	New
4	Hung Phu	15,000	15,000	Hau	Extension
5	Hung Thạnh	10,000	20,000	Can Tho	New
6	Ba Lang	5,000	5,000	Can Tho	
7	Long Hoa	4,000	4,000	Binh Thuy	
8	Tra Noc	40,000	60,000	Hau	Extension
9	O Mon 1	2,500	2,500	O Mon	
10	O Mon 2	30,000	50,000	Hau	New
11	Thot Not 1	20,000	40, 00	Hau	Extension
12	Thot Not 2	30,000	50,000	Hau	New
13	Thạnh Quoi	3,000	7,000	Cai San	Extension
14	Thạnh An	3,000	6,000	Cai San	New
15	Co Do	3,000	7,000	Thot Not	Extension
16	Thoi Lai	3,000	6,000	O Mon	Extension
17	Song Hau 1	-	50 000	Hau	New
	Total	298,500	472,500		

Note :WTPs described above are for urban areas and IZs.
Rural areas will be covered by groundwater supply system.

Source: Can Tho City Master Plan 2030



Source : Can Tho City Master Plan 2030

Figure 4.2.1 Water Supply Plan in Can Tho City Master Plan 2030

4.2.2 Precedent and Ongoing Projects

(1) Con Khuong Project (AFD Project)

The Con Khuong Project, summarized in Table 4.2.2 below, is loaned by the French government and is under the evaluation of AFD as of February 2013. Based on the F/S report prepared for this project, the project aims to supply water to 1) Phong Dien, My Khanh, and Giai Xuan communes in Phong Dien District; and 2) Long Tuyen Ward in Binh Thuy District.

Table 4.2.2 Summary of Con Khuong Project

Item	Contents
(1) Target Year	Phase I (2020), Phase II (2030)
(2) Target Area	Long Tuyen Ward (Binh Thuy District), Phong Dien, My Khanh, and Giai Xuan communes (Phong Dien District)
(3) Population Projection	56,580 (2020), 62,926 (2030)
(4) Water Demand	7,896 m^3/day (2020), 11,302 m^3/day (2030)
(5) Location of WTP	Bui Huu Nghia in Binh Thuy District
(6) Water Source	Hau River
(7) Area of WTP	2.0 ha
(8) Capacity of WTP	10,000 m^3/day (2020)

Source: Con Khuong Water Treatment Plant Project- Phong Dien District, Can Tho City

(2) Hau River Project

The Hau River Project is the one proposed by the Ministry of Construction (MOC) for the water supply system with the target year of 2020 in Mekong Delta Key Economic Zone. The project was approved in Decision No. 2065/QD-TTg on November 12, 2010 and is summarized in Table 4.2.3. In this project, the WTPs for southwestern cities of Hau River were proposed to be constructed through private investment. At present, there is no progress on this project. The Can Tho City Master Plan 2030 is not in compliance with this plan.

Table 4.2.3 Summary of Hau River Project

<table>
<tr><th>Item</th><th>Contents</th></tr>
<tr><td>(1) Target Year</td><td>Planning: 2020, Vision: 2050</td></tr>
<tr><td>(2) Target Area</td><td>Can Tho City, An Giang, Kien Giang, Ca Mau, Soc Trang, Bac Lieu, and Hau Giang Provinces</td></tr>
<tr><td>(3) Water Demand in Can Tho City in 2020</td><td>491,606 m³/day in 2020
=207,798 m³/day (urban) + 52,000 m³/day (rural) + 231,808 m³/day (IZ)</td></tr>
<tr><td>(4) Proposed WTP</td><td>
<table>
<tr><th>No.</th><th>Works</th><th>Design Capacity 2015 (m³/day)</th><th>Design Capacity 2020 (m³/day)</th><th>Water Source</th><th>City or Province</th></tr>
<tr><td>1</td><td>No. 1</td><td>500,000</td><td>1,000,000</td><td>Hau River</td><td>Can Tho, Soc Trang, Ben Tre, and Tra Vinh</td></tr>
<tr><td>2</td><td>No. 2</td><td>1,000,000</td><td>2,000,000</td><td>Hau River</td><td>Can Tho, An Giang, Kien Giang Ca Mau, Hau Giang, and Bac Lieu</td></tr>
<tr><td>3</td><td>No. 3</td><td>200,000</td><td>500,000</td><td>Hau River</td><td>An Giang and Kien Giang</td></tr>
</table>
Note: WTP No. 1 will be located in Tan Thanh Ward, O Mon District, Can Tho City</td></tr>
<tr><td>(5) Proposed Provincial WTP in the Decision</td><td>
<table>
<tr><th>No.</th><th>Names of the WTP</th><th>Design Capacity 2020 (m³/day)</th><th>Design Capacity 2050 (m³/day)</th><th>Notes</th></tr>
<tr><td>1</td><td>Can Tho WTP No. 1</td><td>50,000</td><td>50,000</td><td></td></tr>
<tr><td>2</td><td>Can Tho WTP No. 2</td><td>80,000</td><td>80,000</td><td></td></tr>
<tr><td>3</td><td>Tra Noc WTP</td><td>10,000</td><td>10,000</td><td></td></tr>
<tr><td>4</td><td>Hung Phu WTP</td><td>10,000</td><td>10,000</td><td></td></tr>
<tr><td>5</td><td>Co Do WTP</td><td>15,000</td><td>15,000</td><td></td></tr>
</table>
</td></tr>
</table>

Source: Decision No. 2065/QD-TTg (November 12, 2010), Approving the Water Supply Planning for the Mekong Delta Key Economic Zone in Year 2020

4.3 Water Demand Projection

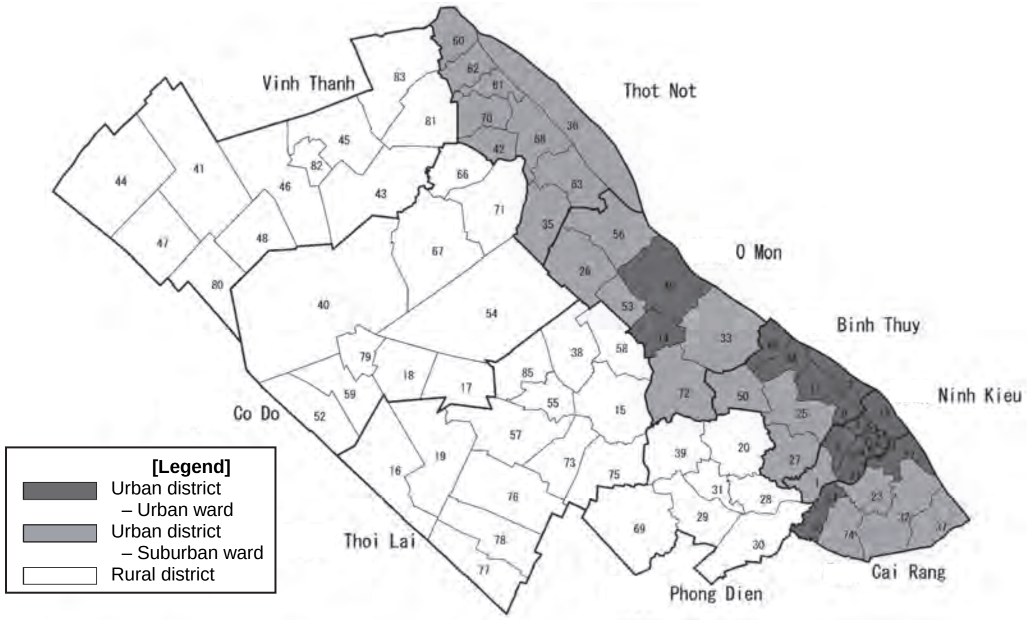
4.3.1 Parameters for Water Demand Projection

(1) Basic Concept for Water Demand Projection

The water demand projection for the target year of 2020 was basically carried out based on the Vietnamese Design Criteria QCVN 07: 2010, QCVN 01: 2008, and TCXDVN 33/2006, issued by the MOC. The parameters used for the projection were based on the abovementioned design criteria and some were modified in consideration of the actual water consumption in the study area.

(2) Urban Classification for Water Demand Projection

The parameters of unit water demand in the design criteria were stipulated in accordance with the urban classification. The urban districts of Can Tho City are categorized as Class I, while the rural districts as Class V. The urban districts are further divided into two categories, namely, urban and suburban wards. The classifications for urban and suburban wards according to the Can Tho City Master Plan 2030 are presented in Figure 4.3.1.



Source: Can Tho PC

Figure 4.3.1 Urban Classifications Used for Water Demand Projection

(3) Parameters for Water Demand Projection

1) Unit Water Demand for Domestic Use

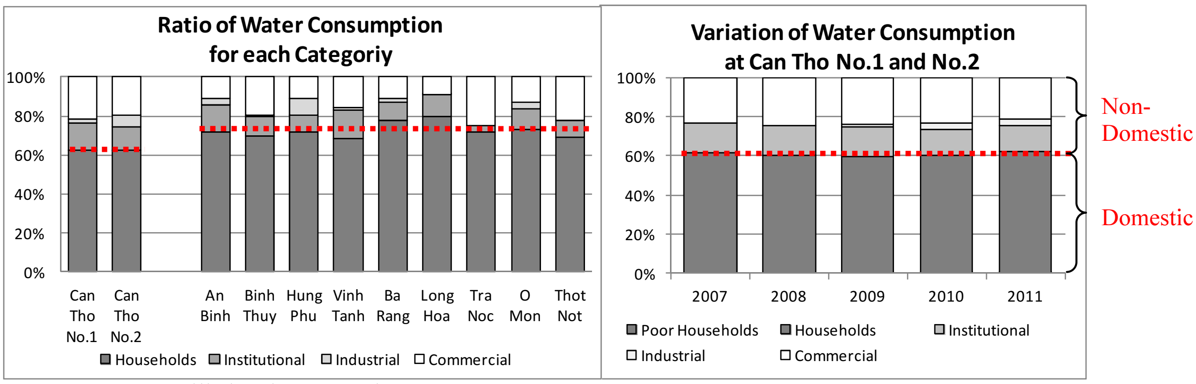
The current condition of water consumption in Can Tho City was described in Section 3.1.2. The unit water demand and service ratio for domestic use in the urban district, which are stipulated in Vietnamese Standard TCXD VN 33: 2006, were applied as the parameters for the water demand projection in this project. On the other hand, a certain number of residents in the rural district are using substantial groundwater up to now, and it seems difficult to quickly restrict groundwater usage by the residents. Therefore, the unit water demand in rural district was slightly modified from 100 L/c/d to 80 L/c/d in consideration of the current water consumption in rural districts. As a result, the unit water demand and service ratio were decided as follows:

- Urban area in urban district: 200 L/c/d with 99% service ratio
- Suburban area in urban district: 150 L/c/d with 95% service ratio
- Rural district: 80 L/c/d with 90% service ratio

2) Water Consumption Ratio for Non-domestic Use

In Vietnamese Standard QCVN 07:2010, the ratios of non-domestic water consumption against domestic consumption are defined in three categories, namely: i) public works and services; ii) plantation, road maintenance, and fire fighting; and iii) commercial and urban services. They shall be defined in consideration of the actual water consumption in Can Tho City.

As explained in Section 3.1.2, billed water volume is recorded to grasp the actual water consumption for four categories: i) households (includes poor households), ii) institutional, iii) industrial, and iv) commercial, as shown in Figure 4.3.2. The figure in the left shows the ratio of water consumption in each category in 2011, while the one in the right shows the ratio in Can Tho No. 1 and No. 2 WTPs distribution area from 2007 to 2011.



Source: WSSC's Billed Volume Data in 2011

Figure 4.3.2 Actual Water Consumption

The average ratios of non-domestic water consumption as against domestic water consumption are calculated in Table 4.3.1. There is a big difference in the ratio between the actual non-domestic water consumption and that of the Vietnamese standard as shown in Table 4.3.1. In this regard, the ratio derived from the actual record is more realistic and will be applied in this Study.

Table 4.3.1 Water Consumption Ratio in 2011

Categories in Billed Water Record in Can Tho City		Water Consumption in 2011		QCVN 07:2010	Categories in Vietnamese Standard
		Can Tho 1 & 2	Another Area		
Domestic		100%	100%	100%	Domestic
Non-Domestic	Institutional	20%	15%	10%	Public works and services
				8%	Plantation, road maintenance, and fire fighting
	Industrial	5%	0%	8%	Commercial and urban services
	Commercial	30%	20%		
	Total	55%	35%	26%	

Note: The water consumption in IZs is excluded in the above calculation.
Source: JICA Study Team

3) Unit Water Demand in Industrial Zone

Although it is preferable to apply the actual water consumption in an existing IZ as the parameter for water demand projection, it is quite difficult to understand the actual water consumption in an existing IZ (such as Tra Noc IZ) because some factories are using the deep wells in their own premises. On the other hand, the standard stipulates that 40 m^3/ha/day is the industrial water demand for a service ratio of 60%. This unit water demand is applied in this project, and the service ratios of IZs in 2020 were proposed at 90% in Tra Noc IZ, 60% in Thot Not No. 1 IZ, and 10% in Hung Phu IZ in consideration of the current occupancy rate and development of IZs.

4) Non-revenue Water Ratio

The ratio of non-revenue water (NRW) is about 34% in the urban district and 16% in the rural district in 2012 as described in Section 3.1.2. The target NRWs for 2020 were derived in accordance with the Government Decision 2147 AD-TTg (signed on November 24, 2010).

5) Others

Daily peak factor and water loss at WTP were set at the median of the parameters stipulated in the Vietnamese Standard TCXD VN 33: 2006. Daily peak factor and water loss at WTP were set at 1.15 and 7%, respectively.

6) Conclusion

In conclusion, the parameters for the water demand projection for this project were decided based on i) the parameters used for the Can Tho City Master Plan 2030, ii) actual water consumption based on the billed volume data in 2011, and iii) unit water demand stipulated in Vietnamese criteria and standard as shown in Table 4.3.2.

Table 4.3.2 Planning Criteria for Water Demand Projection

Category	Item	Unit	Can Tho Master Plan (2020)	Actual in 2011	Criteria in the study for 2020: QCVN 07: 2010	QCVN 01:2008	TCXD VN 33: 2006	Adopted for 2020	Note
I	**Urban Class I (Urban District)**								
	a. Domestic water use								
	Unit water consumption								
	(Urban area)	l/c/d	150	140	-	≧150	200	**200**	
	(Sub-urban area)	l/c/d	120	125	-	≧120	150	**150**	
	(Industrial zone)	m^3/ha/d	30	-	40	20	- *1	**40**	*1: Some industries uses both treated water and groundwater.
	(Industries for food, paper, and textile)	m^3/ha/d			-	-	45	**-**	
	(Other industries)	m^3/ha/d			-	-	22	**-**	
	Service Ratio								
	(Urban area)	%	100	<99	-	≧80	99	**99**	
	(Sub-urban area)	%	100	<95	-	≧80	95	**95**	
	(Industrial zone)	%	70	5～65	≧60	≧60		**90, 60**	Tra Noc: 90%, Others: 60%
								CT-1,2 / Others	Ratio of water consumption for each category are decided based on the water consumtionusase record in 2011.
	b. Public works and services	%	10	12, 10	≧10	≧10	10	**12** / **10**	
	c. Plantation, road maintenance and fire fighting	%	8	8, 5	≧8	≧8		**8** / **5**	
	d. Commercial and urban service	%	-	35, 28	≧8	≧8	10	**35** / **20**	
	e. Non-revenue water								
	(Upgraded system)	%	15	34	≦20	≦30	<20	**20**	
	(New system)	%	15		≦15	≦25	<20		
	f. Water loss at treatment plant	%	-	6.1 - 12.1	≧4	≧4	5 - 8	**7**	
	g. Daily peak factor	-	-		-	-	1.1 - 1.2	**1.15**	
V	**Urban Class V (Rural District)**								Thoi Lai WTP Co Do WTP Vinh Thanh WTP Than An WTP
	a. Domestic water use								
	Unit water consumption	l/c/d	80	60	-	≧80	100	**80**	
	Service Ratio	%	100	<90	-	≧80	90	**90**	
	b. Public works and services	%	10	10	≧10	≧10	10	**10**	
	c. Plantation, road maintenance and fire fighting	%	8	5	≧8	≧8		**5**	
	d. Commercial and urban service	%	-	20	≧8	≧8		**20**	
	e. Non-revenue water								
	(Upgraded system)	%	15	16	≦20%	≦30	≦15	**15**	
	(New system)	%	15		≦15%	≦25			
	f. Water loss at treatment plant	%	-	6.1 - 12.1	≧4%	≧4	10	**7**	
	g. Daily peak factor	-	-		-	–	1.1 - 1.2	**1.15**	

Note: *1: QCVN 07: 2010/BXD, Vietnam Building Code Urban Engineering Infrastructures (Criteria)

*2: QCVN 01: 2008/BXD Vietnam Building Code Regional and Urban Planning and Rural Residential Planning (Criteria)

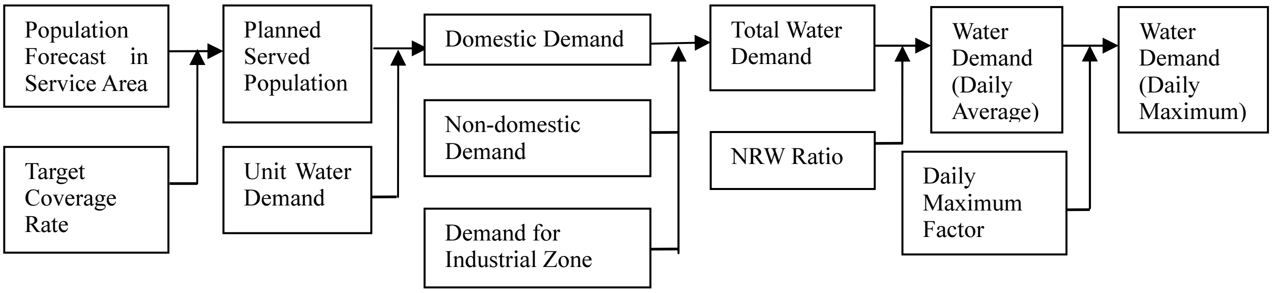
*3: TCXDVN 33:2006 Water Supply- Distribution System and Facilities Design Standard (Standards)

Source: Can Tho Master Plan 2030

4.3.2 Water Demand Projection for 2020

(1) Water Demand Projection Method

The population in the service area was projected based on the GSO's population projection described in Section 2.2.2. Accordingly, the water demand for 2020 was projected with the parameters described in Section 4.3.1. The procedure of water demand projection is shown in Figure 4.3.3.



Source: JICA Study Team

Figure 4.3.3 Flow of Water Demand Projection

(2) Water Demand Projection for 2020

The water demand for 2020 in each WTP's distribution area was projected based on the above definition and procedure, and summarized in Table 4.3.3.

Table 4.3.3 Water Demand Projection for 2020 in Each WTP's Distribution Area

	Population (thousand)	Served Population (thousand)	Domestic Water Demand (m^3/d)	Non-domestic Water Demand: Institutional (m^3/d)	Non-domestic Water Demand: Public (m^3/d)	Non-domestic Water Demand: Commercial (m^3/d)	Water Demand in IZ (m^3/d)	Total Water Demand (m^3/d)	NRW (m^3/d)	Water Demand (Daily Ave) (m^3/d)	Water Demand (Daily Max) (m^3/d)
Can Tho No.1	173	171	33,932	4,072	2,715	11,876	0	52,595	13,149	65,744	75,606
Can Tho No.2	176	174	34,162	4,099	2,733	11,957	0	52,951	13,238	66,189	76,117
Tra Noc	32	30	5,132	513	257	1,026	10,512	17,440	4,360	21,800	25,070
Hung Phu	54	52	8,883	888	444	1,777	1,852	13,844	3,461	17,305	19,901
Thot Not	55	52	7,800	780	390	1,560	2,496	13,026	3,257	16,283	18,726
O Mon	39	38	6,909	691	345	1,382	0	9,327	2,332	11,658	13,407
Bong Vang	10	9	1,020	102	51	204	0	1,377	344	1,721	1,979
Long Hoa	12	12	1,753	175	88	351	0	2,367	592	2,959	3,403
Ba Lang	24	24	4,736	474	237	947	0	6,394	1,599	7,993	9,192
Thoi Lai	16	14	1,159	116	58	232	0	1,565	276	1,841	2,118
Co Do	13	12	927	93	46	185	0	1,251	221	1,472	1,693
Vinh Thanh	22	20	1,615	161	81	323	0	2,180	385	2,564	2,949
Thanh An	16	15	1,176	118	59	235	0	1,588	280	1,868	2,148

Note: As described in Figure 3.1.3 in Section 3.1.2, the distribution area of Can Tho No. 1 WTP will not be expanded, and remaining WTPs' distribution area will be expanded based on the water supply area map for target year 2020, which was established by DOC, DARD and WSSC.
Source: JICA Study Team

4.4 Can Tho City Water Supply Improvement Plan

4.4.1 Water Supply Area

The water supply area in this plan for the target year 2020 was decided in accordance with the water supply area map decided among DOC, DARD, and WSSC in 2012. The water supply area is shown in Figure 3.1.3 in Section 3.1.2. According to the said area map, the distribution area of each WTP will be expanded by the Water Companies.

4.4.2 Capacity Deficit of the WTPs

Water demand in Can Tho City in 2020 was projected in Section 4.3 and the deficit of the WTP's capacity is summarized in Table 4.4.1. The incremental capacity of WTP is about 87,000 m^3/day in total. Most of the incremental capacity in 2020 will be required at WTPs in urban districts, such as 21,000 m^3/day in Can Tho No. 1 WTP and 24,000 m^3/day in Can Tho No. 2 WTP. Currently, the capacities of Can Tho No. 1 and Can Tho No. 2 WTPs are not sufficient and their water productions are approximately 25% and 12% more than their design capacities, respectively, as discussed in Section 3.1.2.

Table 4.4.1 Deficit of WTP Capacity in 2020

(unit: m^3/day)

WTP	Daily Average Water Demand			Daily Maximum Water Demand	Capacity of WTPs (Daily Maximum)		
	Non IZ	IZ	Total	Total	Existing WTPs	On-going Project	Incremental Capacity
Can Tho No.1	65,744	0	65,744	75,606	55,000		**20,606**
Can Tho No.2	66,189	0	66,189	76,117	42,500	10,000	**23,617**
Tra Noc	11,288	10,512	21,800	25,070	20,000		**5,070**
Hung Phu	15,453	1,852	17,305	19,901	10,000		**9,901**
Thot Not	13,787	2,496	16,283	18,726	7,500	2,500	**8,726**
O Mon	11,659	0	11,659	13,407	2,400		**11,007**
Bong Vang	1,721	0	1,721	1,979	2,500		**0**
Long Hoa	2,959	0	2,959	3,403	2,000		**1,403**
Ba Lang	7,993	0	7,993	9,192	5,000		**4,192**
Thoi Lai	1,841	0	1,841	2,117	2,500		**0**
Co Do	1,472	0	1,472	1,693	480		**1,213**
Vinh Thanh	2,565	0	2,565	2,949	3,220		**0**
Thanh An	1,868	0	1,868	2,148	720		**1,428**
Total	**204,540**	**14,860**	**219,400**	**252,308**	**153,820**	**12,500**	**87,163**

Source: JICA Study Team

4.4.3 Water Supply Improvement Plan

(1) Improvement of the WTPs

The water supply system in Can Tho City needs to be upgraded in accordance with the increase in water demand. The basic concepts for the improvement of the water supply system in Can Tho City are proposed in Table 4.4.2, in which current management and operational organizations, such as WSSC, No. 2 LTC, and JSC's, will not be eliminated nor consolidated.

Table 4.4.2 Water Supply Improvement Plan for 2020

Service Area and WTP	Improvement Plan for 2020
Can Tho No. 1	Incremental demand shall be covered by the new WTP with the incremental capacity of 21,000 m^3/day, because of the lack of space for construction in the premises of the existing WTP.
Can Tho No. 2	The service area of Can Tho No. 2 WTP shall be expanded to Long Hoa Ward. Due to the expansion of urban area, the new WTP with the incremental capacity of 24,000 m^3/day will be constructed. The premises of the existing WTP will be utilized for the WTP expansion.
Tra Noc	The incremental demand highly depends on the efficiency of the prohibition of groundwater use in Tra Noc IZ and development of O Mon IZ which is planned to be developed next to Tra Noc IZ. The additional WTP with a capacity of 6,000 m^3/day will be constructed in the premises of the existing WTP.
Hung Phu	The service area of Hung Phu WTP has a huge potential for urbanization because of the development of Hung Phu IZs. In accordance with the progress of urbanization, the additional WTP with a capacity of 10,000 m^3/day will be required. Due to this expansion, the Hung Thanh WTP proposed in the Can Tho City Master Plan will not be required.
Thot Not	A new WTP with the incremental capacity of 9000 m^3/day will be constructed due to lack of additional space in the premises of the existing WTP. The incremental demand will be affected by the occupancy and development of the Thot Not IZs. Therefore, the incremental capacity will be examined in collaboration with CEPIZA.
O Mon	The service area of O Mon WTP has to be expanded. Due to lack of additional space in the premises of the existing WTP, the new WTP with incremental capacity of 12,000 m^3/day will be required. In addition, the water supply plan will be reformulated when the North O Mon IZ is developed.
Bong Vang	The operation of Bong Vang WTP started in 2012. The capacity of Bong Vang WTP will be enough for 2020.
Long Hoa	The capacity deficit is about 1,400 m^3/day in 2020. The incremental demand shall be covered by the Con Khuong WTP or Can Tho No. 2 WTP.
Ba Lang	The expanded WTP with a capacity of 5,000 m^3/day for 2020 will be required.
Thoi Lai	The capacity of Thoi Lai WTP will be enough for 2020.
Co Do	Groundwater is the primary water source of Co Do WTP, which makes it dificult to expand its capacity. The incremental demand is expected to be covered by the new WTP constructed in the Hau River Project.
Vinh Thanh	The capacity of Vinh Thanh WTP will be enough for 2020.
Thanh An	The incremental demand is expected to be covered by the new WTP constructed in the Hau River Project.

Source: JICA Study Team

(2) Improvement of Pipelines (Actions for NRW Reduction)

1) Current Situation of NRW Reduction

The NRW ratio in Can Tho City is 33% in 2012, whereas the target NRW ratio in these areas in 2013, 2015, and 2020 is 26 %, 25%, and 20%, respectively. However, there is no detailed action plan for NRW reduction in WSSC, and future water supply plan AFD including NRW reduction measure have no prospects for progress in near future.

In order to reach the target NRW, the service area of Can Tho No. 1 with water production of

69,000 m^3/day and NRW of 41 % will be the key area for NRW reduction plan.

NRW is categorized into illegal consumption, water leakage, legal non revenue consumption, and non metered consumption. WSSC is unsure of the illegal consumption, legal non revenue consumption, and non metered consumption.

NRW reduction team in WSSC carried out the water leakage detection survey with naked eye, acoustic bar, and electronic water leakage detector for 8,000 households, and repaired connection point in 220 households. 50,000 households have not yet been surveyed, and it is suggested that WSSC shall repair over 1,000 connection points.

2) Proposal for NRW Reduction

Implementing procedure of NRW reduction is differed by the entity and area. Therefore, assessment of current condition and developing of appropriate measure are required for NRW reduction plan.

Table 4.4.3 Stepwise Measure for NRW Reduction

Step	Present NRW Value	Purpose	Measure
1	Over 35%	Reduction of Subastral Water Leakage、Reduction of Meter Loss	Temporary Treatment of Water Leakage, Household Research, Replacement of Water Meter, Public Education (Preparation for Step 2)
2	35 - 25%	Reduction of Underground Water Leakage Reduction of Illegal Connection	Improvement of Accurate Distribution Pipe Map, Establishment of Distribution Pipe Management Area, Training Program for Company Staff, Introduction of Latest Water Leakage Detector
3	30 - 25% (Same as Step 2)	Prevention of Recurrence of Water Leakage	Increasing of Workload for Water Leakage, Replacement of Old Pipe
4	25 - 15%	Intensive NRW Reduction	Review of Existing NRW Reduction Work, Additional Replacement of Old Distribution Pipe
5	15 - 5%	Finishing Touch of NRW Recution	Complete Replacement of Old Distribution Pipe, Rationalization of NRW Reduction Team
6	Under 5%	Mainting of Improved NRW	Minimal Continued NRW Reduction Measure

Source: Nonrevenue Water Management, SUIDO SANGYO SHINBU

A certain level of NRW measure is expected by temporary treatment of water leakage, and replacement of water meter in water supply area of Can Tho No.1 WTP with 41% of NRW.

Currently, WSSC staff is carrying out the water leakage survey by themselves due to the lack of budget for NRW reduction measure. However, prompt recommitment of water leakage survey is required for massive and cumbersome work. In addition, countermeasures for illegal consumption, legal non revenue consumption, and non metered consumption shall be reconsidered in series.

CHAPTER 5 SELECTION OF PRIORITY SCHEME FOR BOT PROJECT

5.1 Establishment of Conditions for Priority Project

5.1.1 Selection of Service Area

The target year of the priority project was set at 2020 as described in Section 4.1. In order to identify the feasibility of the project, the target area of the project was preferentially selected in consideration of the following aspects:

- The area where high incremental water demand will be required;
- The area with high population density; and
- The area where minimum investments for additional transmission and distribution network from WTP are required.

The projected water demand and population density in 2020 are summarized in Table 5.1.1.

Table 5.1.1 Water Demand and Population Density in 2020

Distributing Area	Population (thousand)	Area (km^2)	Population Density (person/ha)	Incremental Demand (m^3/d)
Can Tho No. 1	171	10.8	158	20,606
Can Tho No. 2	175	38.9	45	23,617
Tra Noc	31	9.8	32	5,070
Hung Phu	54	24.1	22	9,901
O Mon	39	19	21	11,007
Thot Not	54	15.5	35	8,726
Bong Vang	10	5.5	18	0
Long Hoa	12	6.5	18	1,403
Ba Lang	24	6.9	35	4,192
Thoi Lai	16	12.1	13	0
Co Do	13	8.6	15	1,213
Vinh Thanh	22	19.6	11	0
Thanh An	16	13.9	12	1,428
Total	**637**	**191.2**	**3.3**	**87,163**

Source: JICA Study Team

In consideration of the above conditions, the service areas of Can Tho No. 1, Can Tho No. 2, Hung Phu, and Tra Noc WTPs were selected as the target areas for the project. In addition, the service area of O Mon WTP was selected as a conditional target area, and will be chosen only as a target area when the selected WTP is located at the O Mon area. On the other hand, Thot Not was not selected as a target area because of the required long transmission line from the city center. Moreover, the service areas of other WTPs were not selected in consideration of their incremental demand and population density.

5.1.2 Selection of the Proposed Site for WTP

The proposed site for WTP was selected based on the following:

(1) Evaluation of the Condition of the Hau River

According to the water quality survey at O Mon area in this study and the raw water quality analysis at Can Tho No. 1, Can Tho No. 2, Hung Phu, and Tra Noc WTPs, there was no significant problem in the proposed sites of WTP in terms of water source qualities.

As for the salinity intrusion of the Hau River, there will be no influence on the water source according to the existing record of salt water intrusions as well as the report of the Mekong River Commission as described in Section 2.1.

On the other hand, the flow rate of Hau River during the dry season is about 1,000 m^3/s, and it was confirmed that there is no significant effect on the river maintenance flow even if the new WTP has been established and starts taking water from Hau River.

(2) Selection of Proposed Site of the WTP

In the selection of the proposed site for the WTP, WSSC's premises is more preferable than private land because neither payment of land acquisition fee nor resettlement of residents is required. However, WSSC's premises, which can be utilized as a construction site of WTP, does not have sufficient space to accommodate the project. Therefore, both private land and WSSC's premises were examined for the selection of the proposed site of the new WTP in this study.

As for the WSSC's premises, the Study Team chose the proposed sites for the new WTPs at the premises of Can Tho No. 2, Hung Phu, and Tra Noc WTPs.

In addition, private lands along the Hau River in Binh Thuy and O Mon districts[1] were surveyed for the new WTPs in consideration of the following: i) availability of land, ii) number of resettlement, and iii) residential development program.

The appropriate area and maximum capacity for a new WTP at the proposed sites are shown in Table 5.1.2.

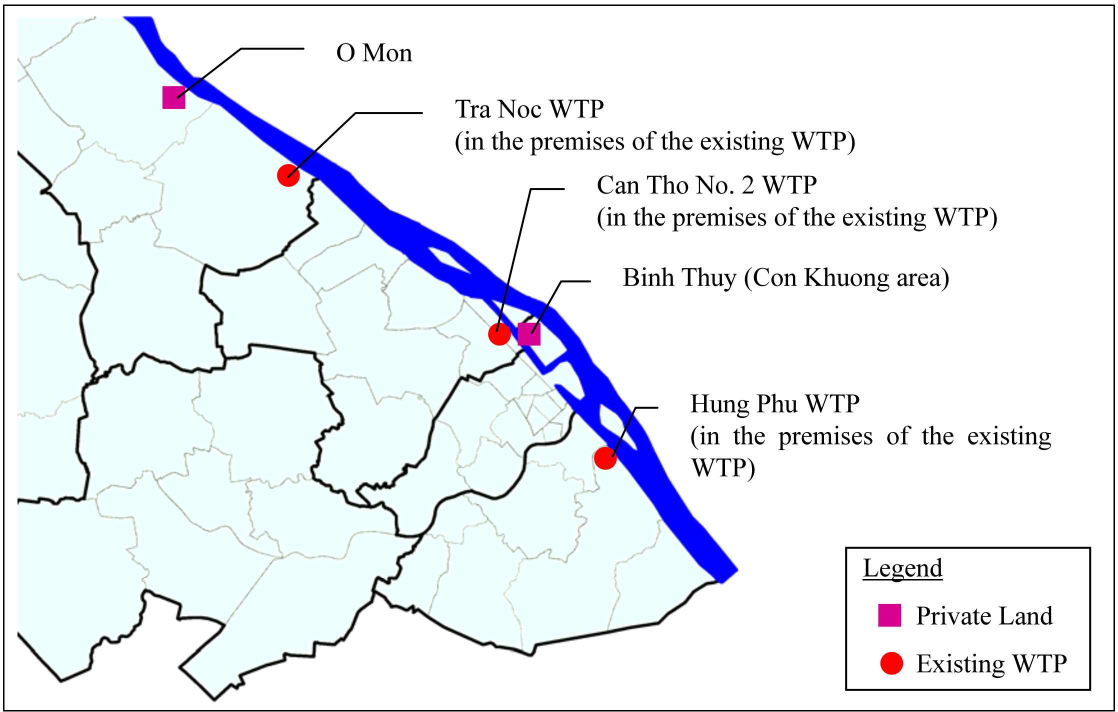
[1] According to the city development plan approved in October 2012, the private land in O Mon area, which was proposed as a WTP site in this study, was decided as a housing development land. This private land is considered as a proposed site of WTP in this report as when the case study was conducted in the study.

Table 5.1.2 Availability of Land and Possible Capacity for WTP

Item	Unit	Private Land		WSSC's Premises		
		Binh Thuy District	O Mon District	Can Tho No. 2 WTP	Tra Noc WTP	Hung Phu WTP
Area	Ha	>3.0	>2.5	1.0	0.6	1.0
Maximum Capacity	m^3/day	>100,000	>100,000	50,000	20,000	40,000

Source: JICA Study Team

As a result of the said preliminary survey, the areas shown in Figure 5.1.1 were selected as the proposed sites for the new WTPs.



Source: JICA Study Team

Figure 5.1.1 Alternative Locations for the Proposed WTPs

5.1.3 Case Study for Optimum System

The alternatives for the case study for optimization were selected as shown in Table 5.1.3 in consideration of the efficiency of the project.

Cases 1 and 2 are alternatives in which one new WTP will be constructed at the private land near the Hau River. New WTPs will be constructed in the premises of the existing WTPs in Cases 3 to 5. The transmission and distribution mains are proposed to supply sufficiently treated water to the target areas. The service area and pipeline length were tentatively proposed as shown in Table 5.1.3.

Table 5.1.3 Case Study Setting for Optimum System

Case	Location of WTP	Capacity of WTP (m^3/day)	Length of Pipeline (km)	Service Area				
				O Mon	Tra Noc	CT-1	CT-2	Hung Phu
Case 1	O Mon (New)	70,000	46.5	○	○	○	○	○
Case 2	Binh Thuy (New)	60,000	18.2		○	○	○	○
Case 3	Premises of Can Tho No. 2	50,000	14.8		○	○	○	
	Premises of Hun Phu	10,000	-					○
Case 4	Premises of Can Tho No. 2	45,000	11.0			○	○	
	Premises of Tra Noc	5,000	-		○			
	Premises of Hung Phu	10,000	-					○
Case 5	Premises of Can Tho No. 2	45,000	11.0			○	○	

Source: JICA Study Team

5.1.4 Preliminary Cost Estimate for the Case Study

(1) Objective of the Preliminary Cost Estimate

Five conceivable cases for urgent development scheme of the water supply system by 2020 were set out for technical and financial evaluation. The objectives of the preliminary cost estimate were to provide information for selecting the priority scheme and conducting preliminary financial assessment of the schemes.

(2) Approaches for Preliminary Cost Estimate

1) Capital Investment Cost

a) Construction cost

The cost of each scheme was estimated based on the facility outline, i.e., location and intake capacity of the WTP, planned bulk supply amount, and pipeline route.

The contract prices of similar on-going water supply projects in Vietnam as listed below were referred to for cost estimation.

i) Thang Long Industrial Park II Development Project (Hung Yen Province, Phase 1: 2007-2009, and Phase 2: 2010-present)
ii) Nhon Trac Water Supply Project (Dong Nai Province, 2007-present)

b) Other costs

- Engineering cost was estimated at 5% of the construction cost.
- Physical contingency was estimated at 5% of the construction and engineering costs.
- Compensation cost was estimated considering the following assumptions:
  i) Ten houses will be affected by constructing a 1-km long pipeline; and
  ii) The compensation fee for one affected house is VND 30 million (referred to Nhon Trach Water Supply Project)
- Renewal cost was estimated based on the following assumptions:

i) The life span of electrical and mechanical equipment is 15 years; and
ii) The ratio of renewal cost to construction cost is set as follows:
- Pump, electric facility: 100%
- Mechanical equipment: 50-75%
- Pipe fittings: 5-20%

2) Operation and Maintenance Costs

a) Electricity cost

The cost for electricity was estimated by multiplying the required power load by the operation hour and electricity rate. The daily operation hour is set as follows:

i) Intake pump: 24 hours
ii) WTP: 10 hours (average running hour)
iii) Distribution pump: Three pumps x 18 hours, one pump x 6 hours

The cost per unit of electricity was set at VND 2,600/kWh referring to the current budget of WSSC.

b) Chemical cost

The chemical cost was estimated by multiplying the planned water supply amount by unit consumption of chemical and unit price of chemical. The unit consumption and unit price of chemicals were set as shown in Table 5.1.4. The unit prices were referred to the current budget of WSSC.

Table 5.1.4 Unit Consumption and Unit Price of Chemicals

Chemical	Unit Consumption (kg/m^3 of raw water)	Unit Price (VND/kg)
PAC	0.009	11,760
Cl_2	0.0021	14,740
Lime	0.0004	4,000

Source: JICA Study Team

c) Maintenance cost

The maintenance cost was estimated by a percentage of the construction cost for the electrical and mechanical equipment. The ratio of maintenance cost to construction cost was set at 0.1% to 1%.

d) Personnel cost

The personnel cost was estimated by referring to the current budget of WSSC. The unit cost for the following staff including several allowances and the office operating costs were set as follows:

i) Operation staff of WTP and pump station: VND 133 million/year/person
ii) Pipeline maintenance staff and supporting staff: VND 124 million/year/person
iii) Management staff: VND 310 million/year/person

e) Sludge disposal cost

The sludge disposal cost was estimated by multiplying the dried sludge volume, which was assumed to be 0.01% of water supply amount, by the unit cost of soil disposal.

(3) Estimated Cost of Each Case

The estimated costs of each case are presented in Table 5.1.5.

Table 5.1.5 Estimated Cost of Each Case

Scheme	Item	Cost (VND Billion)
Case 1 (70,000 m^3/day)	1) Capital Investment Cost	1,477
	Construction of Intake and WTP : 70,000 m^3/day	483
	Construction of the Booster Pumping Station with Reservoir	76
	Construction of Pipeline: 46.5 km	647
	Other Cost	167
	Renewal Cost (Present value)	104
	2) Operation and Maintenance Cost (Present value of 22 years)	566
	Total	2,043
	VND 30.2 million/m^3	
Case 2 (60,000 m^3/day)	1) Capital Investment Cost	804
	Construction of Intake and WTP : 60,000 m^3/day	429
	Construction of Pipeline: 18.2 km	201
	Other Cost	95
	Renewal Cost (Present value)	79
	2) Operation and Maintenance Cost (Present value of 22 years)	261
	Total	1,065
	VND 18.8 million/m^3	
Case 3 (60,000 m^3/day)	1) Capital Investment Cost	748
	Construction of Intake and WTP : 50,000 m^3/day, 10,000 m^3/day	454
	Construction of Pipeline: 14.8 km	137
	Other Cost	70
	Renewal Cost (Present value)	87
	2) Operation and Maintenance Cost (Present value of 22 years)	314
	Total	1,062
	VND 18.7 million/m^3	
Case 4 (60,000 m^3/day)	1) Capital Investment Cost	782
	Construction of Intake and WTP :45,000 m^3/day, 10,000 m^3/day, 5,000 m^3/day	504
	Construction of Pipeline: 11.0 km	107
	Other Cost	72
	Renewal Cost (Present value)	99
	2) Operation and Maintenance Cost (Present value of 22 years)	353
	Total	1,135
	VND 20.0 million/m^3	
Case 5 (45,000 m^3/day)	1) Capital Investment Cost	570
	Construction of Intake and WTP: 45,000 m^3/day	345
	Construction of Pipeline: 11.0 km	107
	Other Cost	54
	Renewal Cost (Present value)	64
	2) Operation and Maintenance Cost (Present value of 22 years)	220
	Total	790
	VND 18.3 million/m^3	

Note: Discount rate for the conversion from each annual cost to present value in this case study was set at 6% per year with reference to similar projects in Vietnam.

Source: JICA Study Team

5.1.5 Selection of Optimum System

Case 5 was selected as the optimum system of the priority project considering the following aspects:

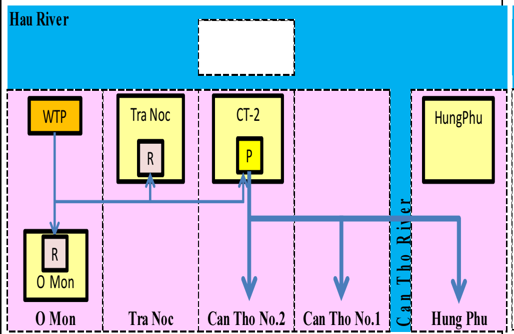
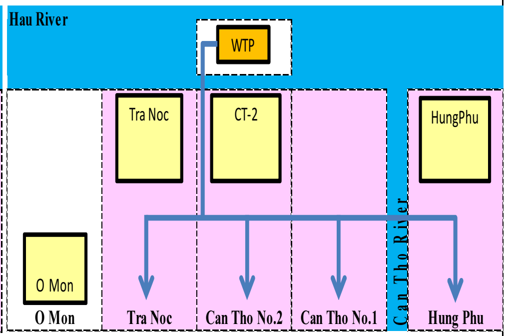
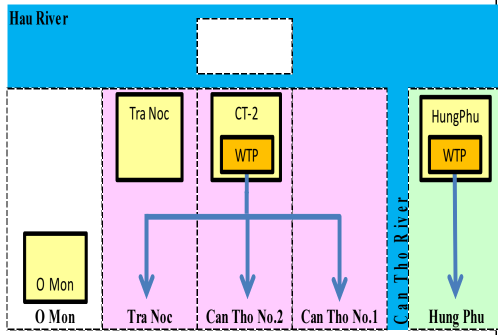
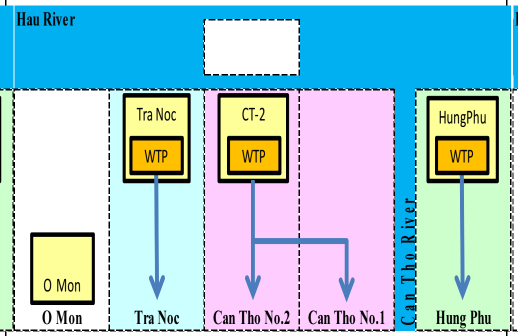
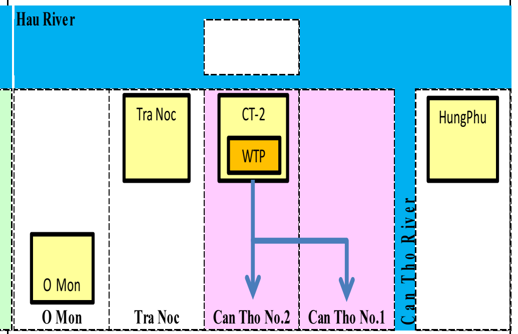
i) The index of "total cost/capacity" was calculated to compare the financial efficiency of each case. As a result of this financial evaluation, Case 5 was selected as the best among the five alternatives.

ii) The new WTP in this case is proposed at the premises of Can Tho No. 2 WTP, and land acquisition and resettlement of residents will not be required.

iii) There is not much demand risk because the IZs in the service areas of Hung Phu and Tra Noc WTPs were not included in this case. There will be some water demand risk in the IZs because the demand will be highly affected by the progress of industrial developments which cannot be controlled by the governmental organizations.

The detailed comparison is shown in Table 5.1.6.

Table 5.1.6 Comparative Chart for the Selection of Optimum Water Supply System

		Case 1	Case 2	Case 3	Case 4	Case 5
Schematic Model						
Brief Summary		New WTP will be constructed in O Mon District and treated water will be served to O Mon, Tra Noc, Can Tho No. 2, Can Tho No. 1, and Hung Phu WTPs' planned area. The length of pipeline is very long; the cost of pipeline is relatively expensive; and the land acquisition process will take long time.	New WTP will be constructed in Binh Thuy District (near Can Tho No. 2 WTP) and treated water will be served to Tra Noc, Can Tho No. 2, Can Tho No.1, and Hung Phu WTPs' planned area. The length of pipeline is relatively short, but the pipe bridge across the Can Tho River is required.	New WTPs will be constructed in the premises of Can Tho No. 2 and Hung Phu WTPs. Treated water of the new WTP in Can Tho No. 2 will be served to Tra Noc, Can Tho No. 2, and Can Tho No. 1 WTPs' planned area. The length of pipeline is relatively short.	New WTPs will be constructed in the premises of Tra Noc, Can Tho No. 2, and Hung Phu WTPs. Treated water of the new WTP in Can Tho No. 2 will be served to Can Tho No. 2 and Can Tho No. 1 WTPs' planned area. The length of pipeline is relatively short.	New WTPs will be constructed in the premises of Can Tho No. 2 WTP. Treated water of the new WTP in Can Tho No. 2 will be served to Can Tho No. 2 and Can Tho No. 1 WTPs' planned area. The length of pipeline is relatively short.
Service Area and Incremental Demand in 2020	O Mon	11,000 m^3/d	-	-	-	-
	Tra Noc	5,000 m^3/d	5,000 m^3/d	5,000 m^3/d	5,000 m^3/d	
	CT-1	20,600 m^3/d	20,600 m^3/d	20,600 m^3/d	20,600 m^3/d	20,600 m^3/d
	CT-2	23,600 m^3/d	23,600 m^3/d	23,600 m^3/d	23,600 m^3/d	23,600 m^3/d
	Hung Phu	9,900 m^3/d	9,900 m^3/d	9,900 m^3/d	9,900 m^3/d	-
	Total	70,100 m^3/d	59,100 m^3/d	59,100 m^3/d	59,100 m^3/d	44,200 m^3/d
Location and Capacity of the WTPs		O Mon (new): 70,000 m^3/day	Binh Thuy (new): 60,000 m^3/day	Can Tho No.2: 50,000 m^3/day Hung Phu: 10,000 m^3/day	Can Tho No.2: 45,000 m^3/day Hung Phu: 10,000 m^3/day Tra Noc: 5,000 m^3/day	Can Tho No.2: 45,000 m^3/day
Land for WTP		3.5 ha	2.5 ha	3.0 ha	3.5 ha	2.5 ha
Area (ha)		WTP: 30,000 m^2 Booster PS: 5,000 m^2	WTP: 25,000 m^2	WTP(CT2): 10,000 m^2 WTP (Sludge area for CT2): 15,000 m^2 WTP (Hung Phu): 5,000 m^2	WTP(CT2): 10,000 m^2 WTP (Sludge area for CT2): 15,000 m^2 WTP (Tra Noc): 5,000 m^2 WTP (Hung Phu): 5,000 m^2	WTP(CT2): 10,000 m^2 WTP (Sludge area for CT2): 15,000 m^2
Land Acquisition		Required (3.5 ha)	Required (2.5 ha)	Approx. 1.5 ha	Approx. 1.5 ha	Approx. 1.5 ha
Current Land Use		Private land/ Agricultural use	Private land/ Agricultural use	WSSC's land/ Land for WTPs Private land/ Agricultural use	WSSC's land/ Land for WTPs Private land/ Agricultural use	WSSC's land/ Land for WTPs Private land/ Agricultural use
Compensation		Required	Required	Expected to be in small amount	Expected to be in small amount	Expected to be in small amount
Pipeline	Transmission	D300 – D800 L=32.5 km	-			-
	Distribution	D400 – D900 L=14 km	D400 – D900 L=18.2 km	D400 – D800 L=14.8 km	D400 – D800 L= 11.0 km	D400 – D800 L=11.0 km
	Total	Total = 46.5 km	Total = 18.2 km	Total = 14.8 km	Total = 11.0 km	Total = 11.0 km
Cost (in Billion VND)	Intake and WTP	483	429	454 (367 (CT2)+ 87 (Hung Phu))	504 (345 (CT2)+72 (Tra Noc)+ 87 (Hung Phu))	345
	Booster PS	76	-	-	-	-
	Pipeline	647	201	137	107	107
	Engineering	167	95	70	72	54
	Renewal	104	79	87	99	64
	O&M	566 (22 years)	261 (22 years)	314 (22 years)	353 (22 years)	220 (22 years)
	Total	2,043	1,065	1,062	1,135	790
Total Cost / Capacity		VND 30.2 million/m^3	VND 18.8 million/m^3	VND 18.7 million/m^3	VND 20.0 million/m^3	VND 18.3 million/m^3
Evaluation		Rank fifth (5th)	Rank third (3rd)	Rank second (2nd)	Rank fourth (4th)	Rank first (1st)

Source: JICA Study Team

5.2 Design of the Proposed Water Treatment Plant

5.2.1 Outline of the Proposal

The study proposes to locate the new water treatment plant in the neighboring premises of the existing Can Tho No. 2 WTP. The site is partly used for sludge discharging from the existing No. 2 WTP. The dimension of the site is about 0.95 ha.

The production capacity of the new WTP is 45,000 m^3/day which was determined based on the water demand projection. The layout is shown in Figure 5.2.1. The WTP adopts a rapid sand filtration system that is the same system with other WTPs of WSSC. The treatment plant consists of the following components as shown in Table 5.2.1 below.

Table 5.2.1 Major Components of the Proposed Water Treatment Plant

No.	Name of Facilities	Unit	Remarks
	Intake pump	3	Pump: Q=16.5 m^3/min (2 + 1 standby, variable speed type)
	Receiving well	1	Rapid mixing by weir flow
	Flocculation chambers	4	Hydraulic mixing by zigzag flow channels
	Sedimentation tanks	4	Vertical up flow type with tube settling, hopper bottomed
	Chlorination chamber	1	Hydraulic mixing, by a zigzag flow channels
	Rapid sand filter beds	8	Constant flow, natural equilibrium, and self washing type
	Clear water reservoirs	2	Flat slab type V=7,500 m^3
	Distribution pumps	3	Pump: Q=23.5 m^3/min (2+1standby)
	Backwater WR tank	1	V=400 m^3
	Sludge R.tank	1	V=35 m^3
	Sludge drying beds	10	Concrete structure, 30 m x 45 m x 1.2 m x 10 beds
	Administration building	1	Office, Lab. Blower R. Meeting R, Other Rs, PAC, Chlorine

Source: JICA Study Team

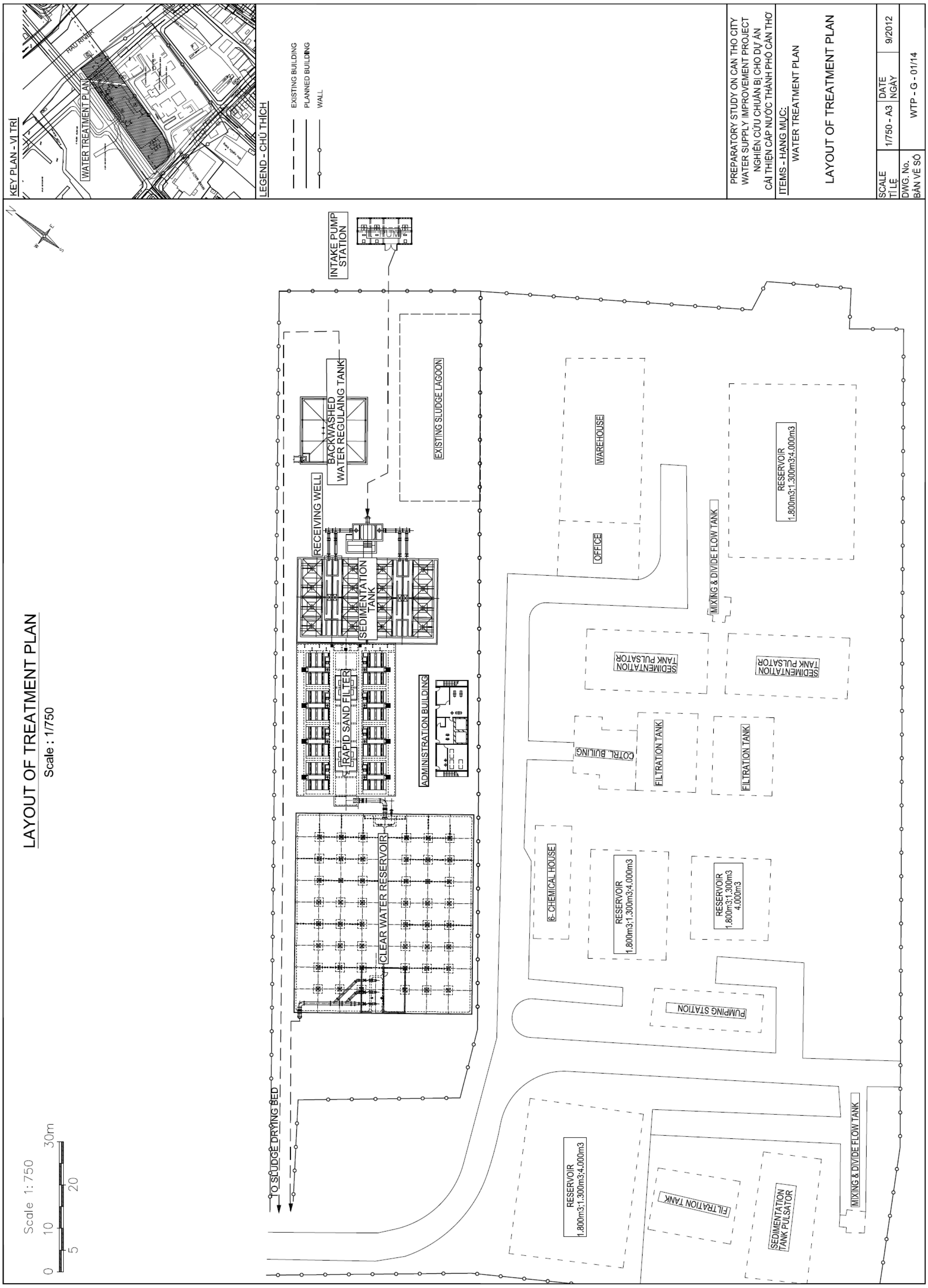


Figure 5.2.1 Layout Plan of the Proposed WTP

Source: JICA Study Team

5.2.2 Topographic and Soil Conditions

The study team carried out a topographic survey of the proposed water treatment plant as well as the sites for the sludge drying beds.

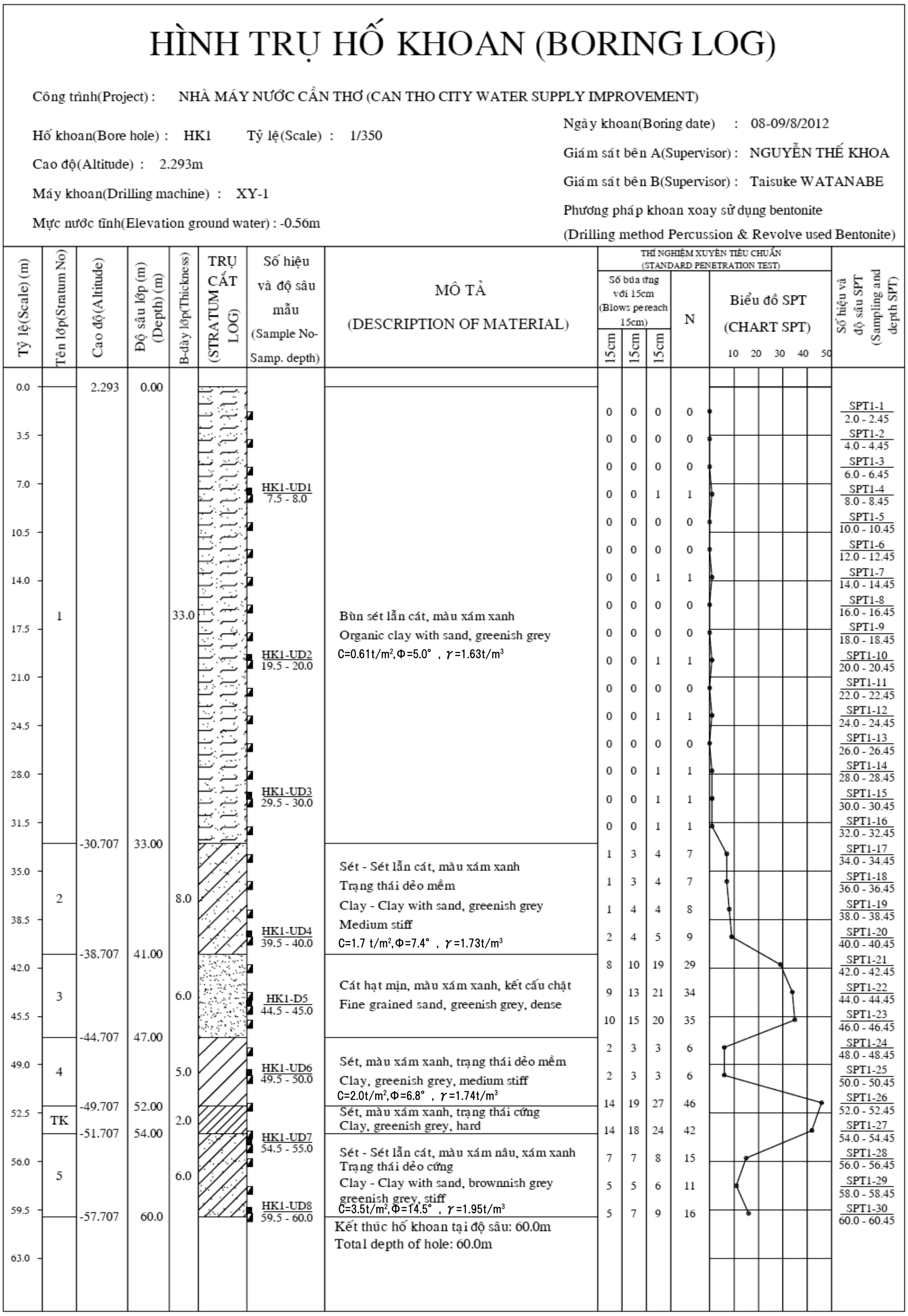
Ground height in the site varies from El 0.75 m from the bottom of the sludge pond to El 3.18 m. The formation level is set to El 2.2 m which is almost the average ground height.

Borings were carried out in two locations. The field boring log of the proposed site is shown in Figure 5.2.2. It was found out that soft clay layer continues from El +2.30 m to El -30.7 m. The N value of the standard penetration test is 0-1, and the cohesion of the soil is 0.6-0.7 t/m^2. The boring log shows that at El -30.7 m, the soil changes from clay to sandy clay. The N value is from 7 to 9. The fist bearing layer appears at El -38.7 m, and the soil is fine grained sand with N value from 29 to 35 and thickness of 6 m. The soil becomes soft clay at El -44.7 m. The N value drops to 6. This layer continues to El -49.7 m and thickness is about 5.0 m. The second hard layer appears at El -49.7 m. The N value is from 42 to 46 and thickness of only 2 m. This soil condition requires that all the major facilities of the plant must be supported by concrete piles to prevent settlement caused by the loaded weight. The possible bearing layer should be at the first hard layer at El -38.7 m with N=30. The soil condition will also require sheet pipes for earth retaining works especially for deep structures such as clear water reservoir and the backwash wastewater regulating tank.

The water level varies with a range of 3.55 m . The highest high water level reaches El +2.05 m and the lowest low-water level reaches El -1.5 m. The groundwater level observed during the boring was at El +1.7 m, which is affected by the river water level.

5.2.3 Flow Diagram

Figure 5.2.3 shows the flow diagram of the proposed treatment plant including chemical dosing points, water level in the tanks and filters, and major valves and siphons.



Source: JICA Study Team

Figure 5.2.2 Boring Logs at the Proposed Plant Site

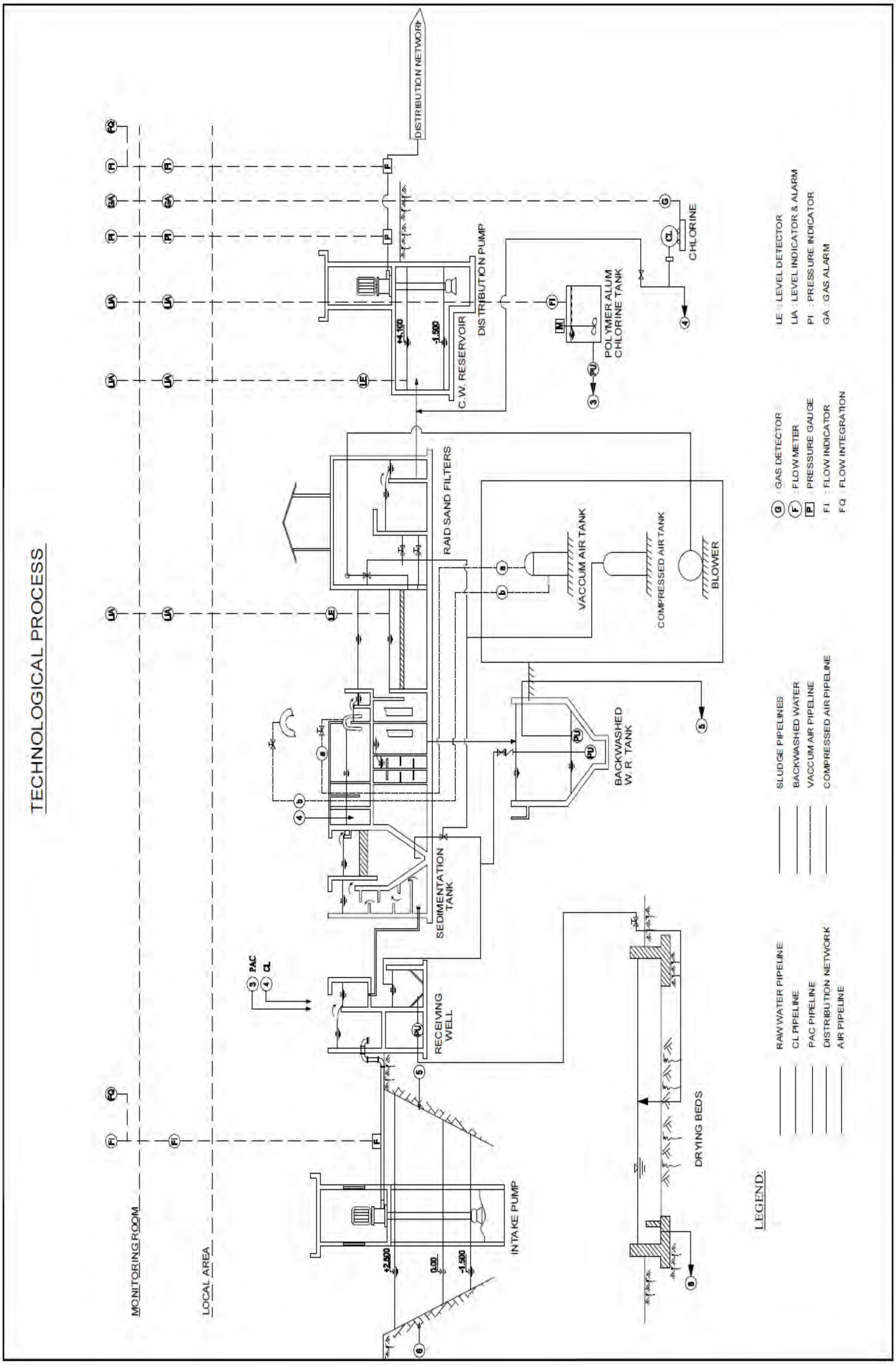


Figure 5.2.3 Flow Diagram of the Proposed Treatment Plant

Source: JICA Study Team

5.2.3 Treatment Process

(1) Intake Pump and Station

The proposed intake pumping station will be located in the Khai Luong Canal and at the immediate upstream of the existing pumping station. It will be constructed on concrete piers driven into the canal. Three pumps (one standby) will be installed at the station together with their control panels. A raw water pipeline is proposed to be installed at the station. The beams of the bridge will be established between the WTP and the pumping station.

Each pump will have the same pumping capacity and head, Q=16.5 m^3/min x 15 m. The motor of the pump will be controlled by an electric device called variable voltage variable frequency (VVVF).This system was selected based on the result of a comparative study in which a conventional fixed speed pump system with a butterfly valve and a VVVF system were compared from both technical and economical points of view.

The reason why it is necessary to adopt the VVVF system is mainly because the tide river water level varies from time to time and the maximum water level difference becomes 3.55 m. It is about 23% of the maximum total head. In this situation, especially during high tide, the fixed speed pump system needs to give a water head loss through the flow control valve, which is the same height as the river water raised by tide; therefore, this system will cause big energy losses. The VVVF system on the other hand will be able to adjust the flow by changing the revolution of the motor, and will cause very few energy losses compared to the fixed speed system. The only biggest problem of the VVVF is its initial cost. The VVVF system is more expensive than the conventional one.

The summary of the study is shown in Table 5.2.2 below and the detail is presented in Appendix C1.

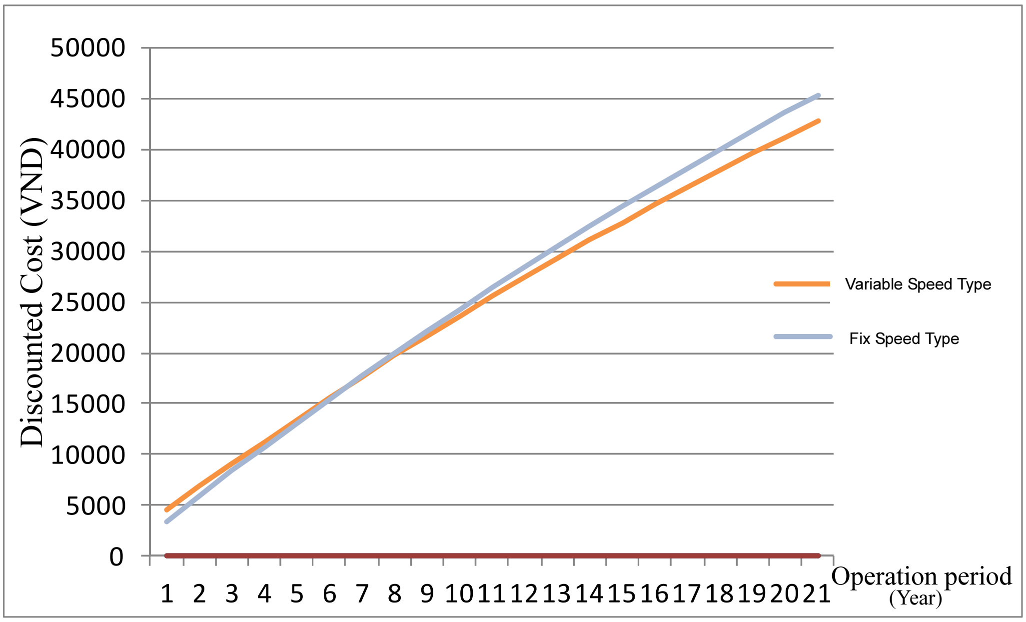
Table 5.2.2 Comparison of Variable and Fixed Speed Pumps (Intake Pumps)

Items to be Compared	Variable Speed Pump	Fixed Speed Pump
Initial cost of control system	VND 2.23 billion	VND 850 million
Power required	86.1 to 110.3 kWh	112 kWh
Electricity consumption	897,700 kW/year	984,500 kW/year
Unit price of electricity	VND 2,600/kW	VND 2,600/kW
Annual electricity cost	VND 2.33 billion	VND 2.56 billion
Breakeven point of cost	6 to 7 years (See Figure 5.2.4)	

Source: JICA Study Team

In the comparison, the common costs for both systems such as pumps and motors were canceled and items that differ among them were considered. The costs considered were then evaluated using the net present value method. A discount rate of 2% was used for this Study.

Figure 5.2.4 shows the cumulative discounted value for each year. The cost line closes at 6-7 years from the beginning of the operation.



Source: JICA Study Team

Figure 5.2.4 Cumulative Discounted Costs

(2) Raw Water Transmission Pipeline

A raw water pipeline of 700 mm diameter will be installed between the intake and the receiving well. The material is ductile cast iron or carbon steel. An ultrasonic flow meter will be provided in the raw water pipeline. The electric signal will be transmitted to a monitoring room in the administration building. The flow rate will be displayed on a visual display unit (VDU) in the room. Poly Aluminum Chloride (PAC) dosing and controlling of the intake pump will be carried out with this flow rate.

(3) Receiving Well

The retention time of the receiving well will be 1.5 minutes. Two rectangular weirs installed on top of the receiving well will split the flow into two. PAC coagulant will be applied to the water that flows over the weirs, and rapid mixing will be carried out by using the energy of falling water. Chlorine will also be applied occasionally to the water to prevent algae growth. An overflow pipe will be provided in the well to prevent overflow due to an expected operation of the subsequent processes. The receiving well will be supported by a piled foundation.

(4) Flocculation Chambers

Four flocculation chambers are proposed. The coagulated water from the receiving well will enter the flocculation chambers. Each chamber will have a long channel which has many baffle walls in it, and the walls will make the channel to a horizontal zigzag channel. The retention time will be about 15 minutes. Flocculation will be carried out by hydraulic energy of water turbulence that is caused by the baffle walls. Flow velocity in the channel will be 10-25 cm/sec and the mixing intensity will be reduced to several steps to attain tapered flocculation. With this speed, floc and suspended solid in coagulated water will not settle in the channel. However, considering the maintenance, the channel will have a tapered bottom with lean concrete that can collect sludge accumulated at the bottom and can convey it downwards with flush water. The flush water will be supplied by the neighboring chamber; therefore, no handling by labor will be necessary for sludge draining and channel cleaning purposes. The drain water and sludge will be sent to the backwash wastewater regulating tanks. Two flocculation chambers and two sedimentation tanks will be combined in one structure and will be supported by a piled foundation.

(5) Sedimentation Tanks

The WSSC is operating various up flow type sedimentation tanks which are called as “pulsators” or “accelators”. If this type of sedimentation tank will be used, the tank surface area of 650 m^2 becomes necessary. The surface loading rate used in the estimation is 50 mm/min according to the Japanese design criteria. This requirement will make the tank layout in the proposed site difficult because due to very limited space and geometry. To reduce space, settling device must be adopted. A technical trial concluded that an up flow sedimentation tank with tube settler will be most appropriate for this plant.

Advantages of this sedimentation tank are i) the water losses that go with sludge draining is smaller than the pulsator, because the sludge is expected to thicken in the hopper; ii) no mechanical equipment will be installed; and iii) easy operation and maintenance (O&M).

(6) Intermediate Chlorination Tank

The tank will be provided between the sedimentation tanks and the rapid sand filter. The objective will be to chlorinate water after the sedimentation tank and prior to the rapid sand filter. It will remove manganese due to oxidation by chlorine.

The self-washing rapid sand filter will backwash one filter bed with filtered water of the other beds. Thus, backwashing with chlorinated water will prevent pollution of under the drain system of the filter. The retention time will be 15 minutes. Mixed water and chlorine will be carried out hydraulically by the horizontal zigzag channels with baffle walls. The intermediate chlorination tank and filter will be a combined structure supported by a piled foundation.

(7) Rapid Sand Filters

The rapid sand filter will a constant rate, natural equilibrium and self-washing type.usually called as “green leaf filter”. The filtration and backwash rate will be 150 m^3/m^2/day and 0.8 m^3/m^2/minute, respectively. An air scouring system and backwash troughs will be provided in each filter bed to increase backwashing efficiency and speed. Inflow to the filter beds and backwashed water will be controlled by siphon system. The features of this filter are as follows:

i) This filter eliminates backwash pumps. Other types like Aquazur filter use a large capacity of backwash pumps. The size depends on the bed area; however, it is almost the same size as intake pumps. Therefore, this filter will reduce the initial and O&M costs.

ii) This filter does not have a flow control device for filtered water. A constant flow rate is maintained naturally. Water level in the filter bed increases as filtration loss is increased. Backwashing is carried out manually when the water level approaches the high water level; and inflow to the filter beds stops when the water level finally reaches the high water level automatically.

iii) Two siphons control inflows to the filters and backwash wastewater discharge from filter bed. The siphons are operated by vacuum tank and small vacuum pump. This system responds quickly without trouble compared to a valve operated type.

iv) The disadvantage of this type of filter is that the depth of filter tank is 1.0 m deeper than the other type. However, it will not be economically serious because civil work is usually cheaper than the mechanical equipment and O&M work is easier than the other types.

Water level in each filter is measured electrically and the signal is transmitted to the monitoring room in the administration building and indicated on the VDU together with an alarm. Plant operators can judge the timing of backwashing based on the transmitted information.

(8) Clear Water Reservoir

The clear water reservoir is a flat slab type divided into two sub-tanks by a partition wall. The retention time and the capacity will be 4.0 hours and 7,500 m^3, respectively. The size is 45 m x 20 m x 4.2 m deep x 2 sub-tanks. The retention time was determined based on a result which was obtained by analyzing the water distribution data of the Thot Not WTP. The analysis showed that the minimum retention time was 3.5 hours. The retention time for this reservoir added some allowance and determined in hours. Detail of the analysis is presented in Appendix C2.

A small chamber will be provided at the inlets of the reservoir where chlorine will be applied to the treated water. The chamber has two gates which switches the inflow to the sub-tanks when one of the sub-tanks has been emptied. Each sub-tank has walls between columns which guides flow in the tank to a chamber where distribution pumps are installed. Chlorination takes place at the inlet chamber.

An overflow will be provided in the tank where overflowing water goes to the river by gravity. Draining of the tank will be carried out by pump, because the tank bottom of the reservoir will be situated below the water level of the river, therefore, gravity drain is not possible. When the tank has been emptied, a portable submersible pump will be installed at the pit.

The water level of the reservoir will be measured electrically and the signal will be transmitted to the control room in the administration building. The signal will be indicated on the VDU. An alarm which tells the abnormality of the water level is also shown on VDU.

A distribution pump house and an electric room will be provided at the clear water reservoir. These structures including the clear water reservoir will be supported by piled foundation.

(9) Distribution Pumps

Three distribution pumps (one is standby) will be installed in the pump house, all of which are variable speed type. The capacity and the maximum head of each pump are 23.5 m^3/min and 40 m, respectively. The type of pump is vertical shaft and mix flow type.

A comparative study was carried out to determine the flow control system of the distribution pump. Fixed and variable speed types were compared. The hydraulic condition of the pump was estimated from a result of flow net analyses of distribution pipes, and condition of the pumps' operation was estimated from the water distribution data of the Thot Not Plant. The detail of the study is presented in Appendix C3. The summary of the comparison is shown in Table 5.2.3.

Table 5.2.3 Comparison of Variable and Fixed Speed Pumps (Distribution Pumps)

Items to be compared	Variable speed pump	Fix speed pump
Initial cost of control system	VND 4.25 billion	VND 1.28 billion
Power required	86.5 to 110.3 kWh	199 kWh
Electricity consumption	1,646,800 kW/year	3,050,670 kW/year
Unit price of electricity	VND 2,600/kW	VND 2,600/kW
Annual electricity cost	VND 4.28 billion	VND 7.93 billion
Breakeven point of the cost	1 year	

Source: JICA Study Team

As the result shows, the variable speed recovers the installation cost of VVVF in the first year of the operation. The electricity consumption of the variable speed type is about 54% of the fixed speed type.

A part of the distribution pipe in the WTP yard will be installed on the clear water reservoir, and a flow meter and a water pressure sensor will be installed in this section. The electric signals will be transmitted to the monitoring room in the administration building and displayed on the VDU. The distribution pumps will be controlled by a microcomputer that will use this information for controlling, and minimum water pressure in the distribution network will be kept at 0.1 MPa constantly throughout the day.

(10) Backwash Wastewater Regulating Tank

The regulatiing tank receives backwash wastewater from the rapid sand filter and decants the water. The tank capacity is 400 m^3 which is of equivalent volume with the wastewater produced by one backwashing. The tank will hold the water for several hours until it separates into supernatant and sludge. Two submersible pumps will be installed in the tank. One pump will be located in the middle place of the tank and will discharge the supernatant to the river. It will be operated by the water level of the tank and by timer.

The other pump will be located at the bottom of the tank and will discharge sludge to the sludge regulating tank. It will be operated manually.

(11) Sludge Regulating Tank

This tank is a compound structure with a receiving well that receives sludge drained at the sedimentation tank. The capacity is 35 m^3. The drained sludge will enter to this tank on pulse interval. The pulse flow will be regulated holding the sludge in the tank to attain constant pumping. Two progressive cavity pumps (one is standby) will be installed at a pump house that will be situated under the receiving well. The pumps will be operated with the water level of the tank.

(12) Sludge Drying Beds

The sludge drying bed receives what will be transmitted from the sludge regulating tank. The sludge will be dewatered using natural energy such as sunlight and wind.

Sludge drying bed is a concrete structure. Partition walls made of concrete will be divided into some beds. At the bottom of the beds, a sand layer will be placed above groundwater table to ease dewatering.

5.2.4 Chemical and Storage

(1) Coagulant

Existing WTPs use powder PAC with an aluminum oxide concentration of 30%). The proposed WTP will use liquid PAC with an aluminum oxide concentration of 10% because of the following advantages:

i) Cost is economical. Comparison cost is shown in Table 5.2.4;
ii) Floc settling velocity is higher and optimum dosage is lower (refer to Appendix B3);
iii) Easy handling as the dissolving work is not necessary; and
iv) There is almost no chance for rubbish to enter into PAC storage tank, therefore PAC dosing pump does not clog.

Table 5.2.4 Cost Comparison of Powder and Liquid PAC

PAC	Cost (VND/kg)	(1) Al_2O_3 Cost (VND/kg)	(2) Trans. Cost (VND/kg)	(3)=(1)+(2) (VND/kg)
Powder (30%)	11,760	39,200	67	39,267
Liquid (10%)	3,000	30,000	200	30,200

Source: Liquid Price: Bien Hoa Chemical Co.; Powder Price: WSSC; Transportation Cost: VND 200,000/ton by JICA Study Team.

Two PAC storage tanks with a capacity of 20 m^3 each will be provided in the chemical room in the administration building. It will be equivalent to 15 days storage during the wet season and 45 days storage during dry season. The PAC will be transmitted by diaphragm pumps and will be dosed at the receiving well.

(2) Disinfectant

Liquid chlorine will be used in the proposed WTP. It will be supplied by one tone cylinder to the site. A chemical room will be provided in the administration building. The floor will be lowered by about 0.5 m than the other places.

The lowered floor retains chlorine gas when it leaked. A chlorine sensor installed on the floor will detect the leaked chlorine, and will send the signal to the control room. The signal will be displayed on the VDUs, and warning tones will beep at the same time. In this event, lime powder will be thrown in to neutralize the leaked chlorine. A scale will be installed in the room, and will measure the weight of the cylinder to monitor the chlorine remaining in the cylinder.

5.2.5 Administration Building

The administration building includes the following rooms: 1) monitoring room, 2) laboratory, 3) office, 4) meeting room, 5) machinery room, 6) workshop, 7) chemical room, 8) chlorination room, and 9) other rooms. The machinery room will be installed with blower for air scour of the rapid sand filter and compressor for pneumatic valves.

The administration building will have two stories. The ground floor will have the machinery room, workshop, and storage; while the second floor will have the monitoring room, laboratory, office, meeting room, and toilet. A connection bridge will be provided to connect the administration building and the rapid sand filter.

5.2.6 Electrical and Mechanical Works

(1) Pumping Facilities

Intake and distribution pumps are the major pumps in the plant. These pumps are variable speed types. The operation system was selected after conducting comparative studies; the detail is shown in 5.2.3 (1) and (8). For maintenance purposes, intake station will be installed with motorized chain blocks with lifting capacities of 3-3.5 tons.

For the backwashing of the filter, two root type blowers will be installed in the machinery room in the administration building. The capacity is 10.8 m^3/min x 60 kPa x 18.5 kW.

There will be other small pumps. The backwash wastewater tank has two submersible pumps; one for sludge and the other for supernatant.

The sludge regulating tank has sludge pumps, which pump 2% or higher concentration sludge and discharge to sludge drying beds. Progressive cavity pumps were selected as sludge pump.

Diaphragm type was selected for PAC dosing pump. This pump changes the flow by displacement stroke. Since PAC is a strong acid, the pump body and other parts are made of anti-corrosive materials such as stainless steel. The pipes will be made of PVC.

(2) Power Receiving

Electricity for the WTP will be supplied by Can Tho Power Corporation. The company and JICA Study Team had a meeting last July 10, 2012 to establish the supply conditions. The meeting confirmed the following:

i) Maximum electric load of the WTP is 700 kW

ii) The electricity will be supplied either from 22 kV lines which runs along Cach Mang Thang 8 Street, or from a transmission line of the existing Can Tho No. 2 WTP.

iii) A transmission line will be installed from the branching point to the proposed WTP with the same voltage of 22 kV.

iv) A power receiving transformer will be installed in the proposed WTP, and the voltage will be stepped down to 380 V.

v) All installation work up to item iv) will be carried out by the Electric Company, and all other works will be carried out by SPC.

The power receiving transformer will be located near the electrical room on the clear water reservoir. A main power line will be connected to a receiving power panel in the electric room. The power will be distributed to each loading point. Each loading point will have a local panel, where switching and control of electricity will be carried out. A schematic diagram is shown in Figure 5.2.5.

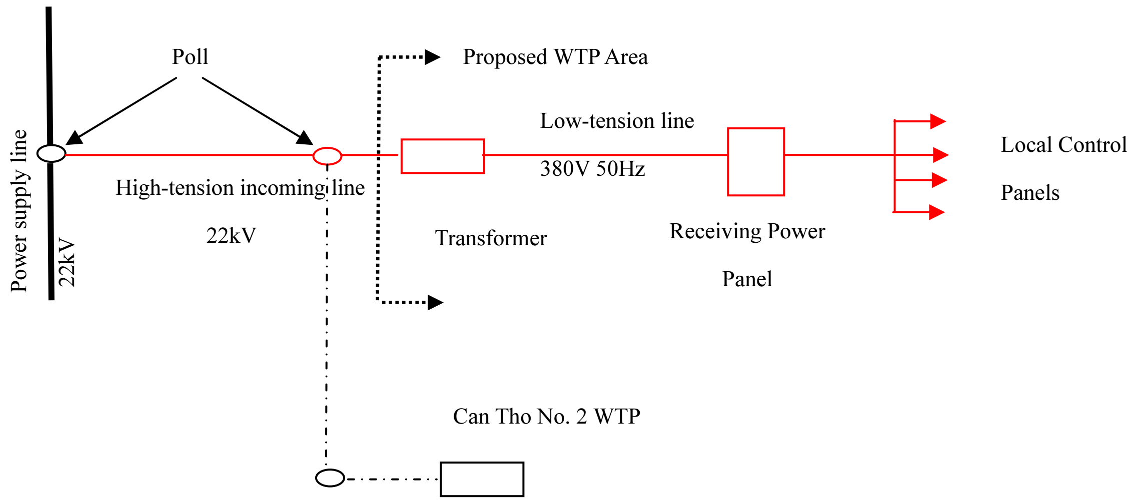


Figure 5.2.5 Schematic Diagram of Power Supply

(3) Backup Power Supply

According to the records from 2009 to 2011, there were occasional power outages in Can Tho City. In case of power outage, the generator will be required for sustainable water supply. The power of generator was decided for the operation of the facilities listed in Table 5.2.5.

Table 5.2.5 Load List Covered by the Backup Power Supply

Name of Equipment	Quantity	Loads (kW)
Intake pump	1	60
Distribution pump	1	220
Chemical dosing	LS	5
Office and other	LS	15
Total		300

An uninterrupted power supply system consisting of batteries will be provided in the monitoring room. The system will supply electricity to instrumentation system and computer including the logging system.

(4) Control and Monitoring System

The proposed WTP will be composed of the following seven facilities: 1) intake pumps, 2) receiving well, 3) sedimentation tanks, 4) rapid sand filter, 5) distribution pumps, 6) sludge treatment facility, and 7) chemical dosing facility. Operational information from these facilities will be transmitted to the monitoring room, and displayed on the VDUs. Some types of information which is hazardous for operators and neighbors like chlorine leakage will be indicated by with a warning tone. Detail of the information flow is shown in Figure 5.2.2.

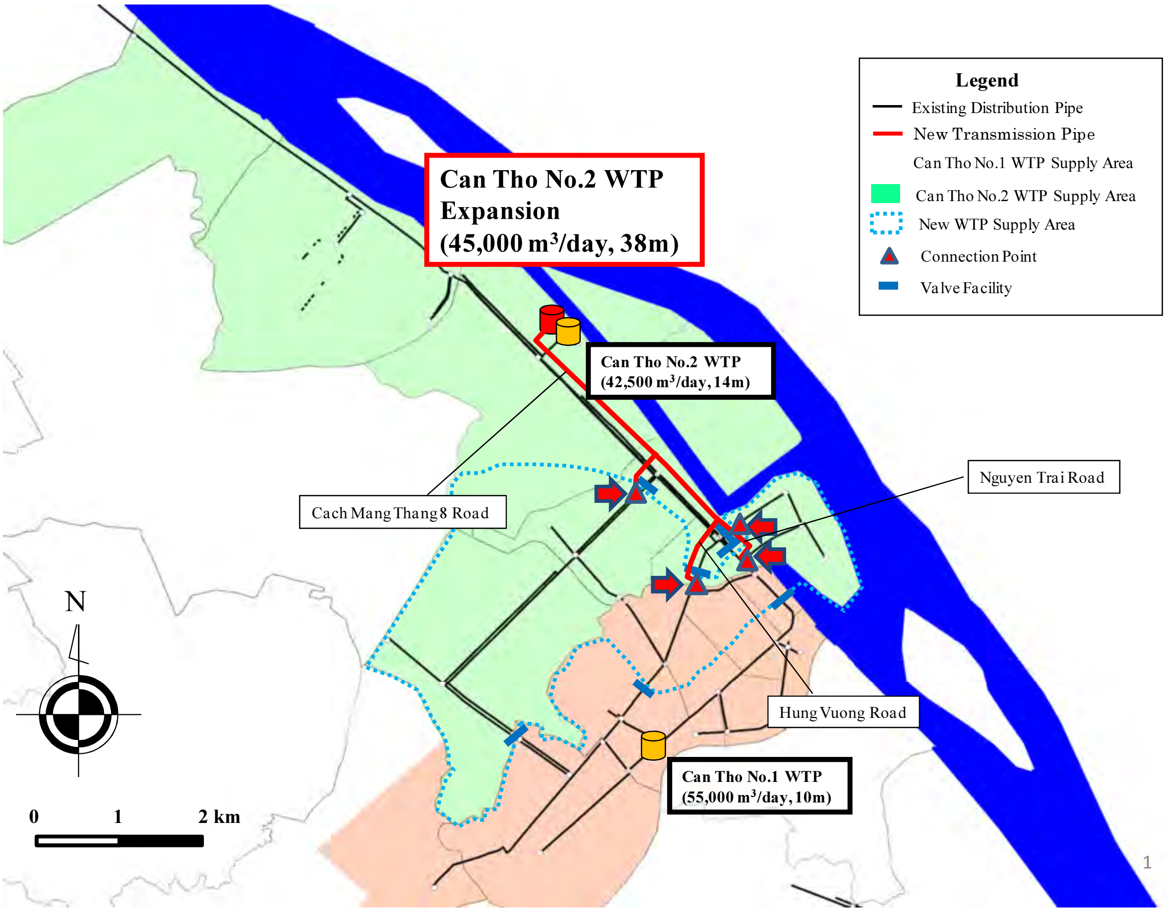
The equipment inside the facilities will be operated or adjusted at the local panel. However, intake and distribution pumps will be partly operated automatically. Intake pumps flow rate will be initially set manually. After setting, the pumps will be automatically operated by a microcomputer so as to keep the flow rate constant changing only the revolution speed of the pumps. The distribution pumps will also be operated automatically by a microcomputer. The computer will estimate the minimum water pressure in the water supply area based on the flow rate and water pressure at the WTP. Then, it will set the revolution speed of pumps so that minimum water pressure in the water supply area can be maintained at 0.1 MPa.

Backwashing process of the filter will be started manually, and the following procedures will be carried out sequentially by the microcomputer.

5.3 Transmission Systems

5.3.1 Outline of the Transmission System

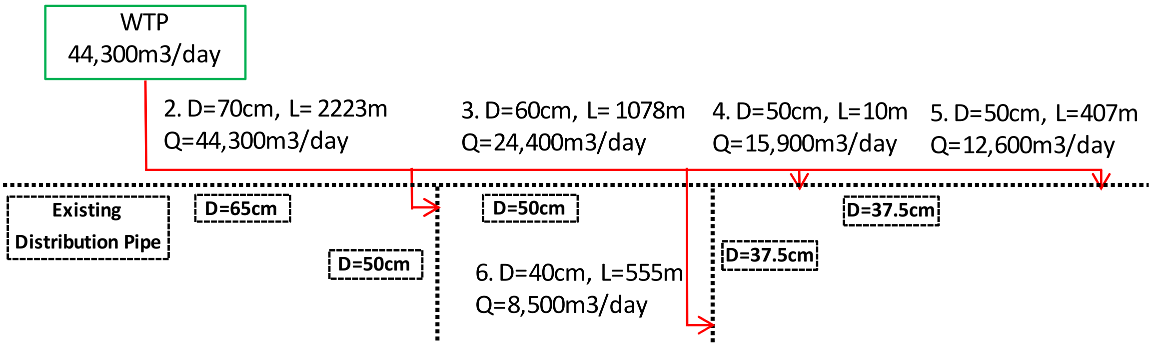
In the proposed transmission system, the treated water from the new WTP is to be transmitted to the connection points on the existing distribution pipeline network, then to be distributed via the existing distribution pipeline network. Figure 5.3.1 shows the outline of the proposed transmission system.



Source: JICA Study Team

Figure 5.3.1 Outline of Proposed Transmission System

The water supply area of each WTP is divided by valve facilities to boost water pressure without water flow obstruction. The proposed transmission pipeline is designed with minimal pipe length and diameter to reduce the water head loss and construction cost. Figure 5.3.2 shows the schematic diagram of the proposed transmission pipeline.



Source: JICA Study Team

Figure 5.3.2 Schematic Diagram of Proposed Transmission Pipeline

5.3.2 Pipeline Alignment

(1) Pipeline Route

The transmission pipeline starts from the WTP and runs along the Cah Man Thang Tam Road. The pipeline branches at the cross section in Thoi Binh Ward. One pipeline goes along Nguyen Trai Road and the other goes along Hung Vuong Road. The general layout map of the pipeline is shown in Drawing G-1/1.

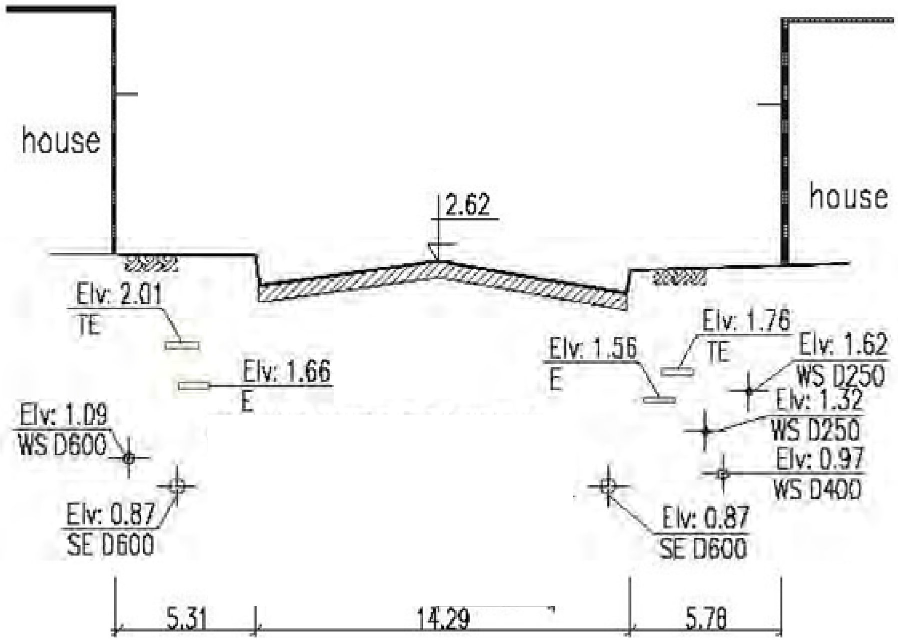
(2) Existing Underground Utility

The width of the above national road is 13-18 m and the side walk is 5 m. The underground utilities such as telephone cable, water distribution pipe, sewer pipe, and electrical cable are buried under the road.

The bedding depth of underground utilities is as follows:

- Telephone cable : 1.0 - 1.2 m
- Water distribution pipe : 0.7 – 1.5 m
- Sewer pipe : 0.3 – 2.0 m
- Electrical cable : 1.0 – 1.2 m

The typical cross section of the national road with indication of underground utilities is shown in Figure 5.3.3.



Note: TE: Telephone Line, WS: Water Distribution Pipe, SE: Sewer Pipe, E: Electrical Cable, Elv: Invert Elevation
Source: JICA Study Team

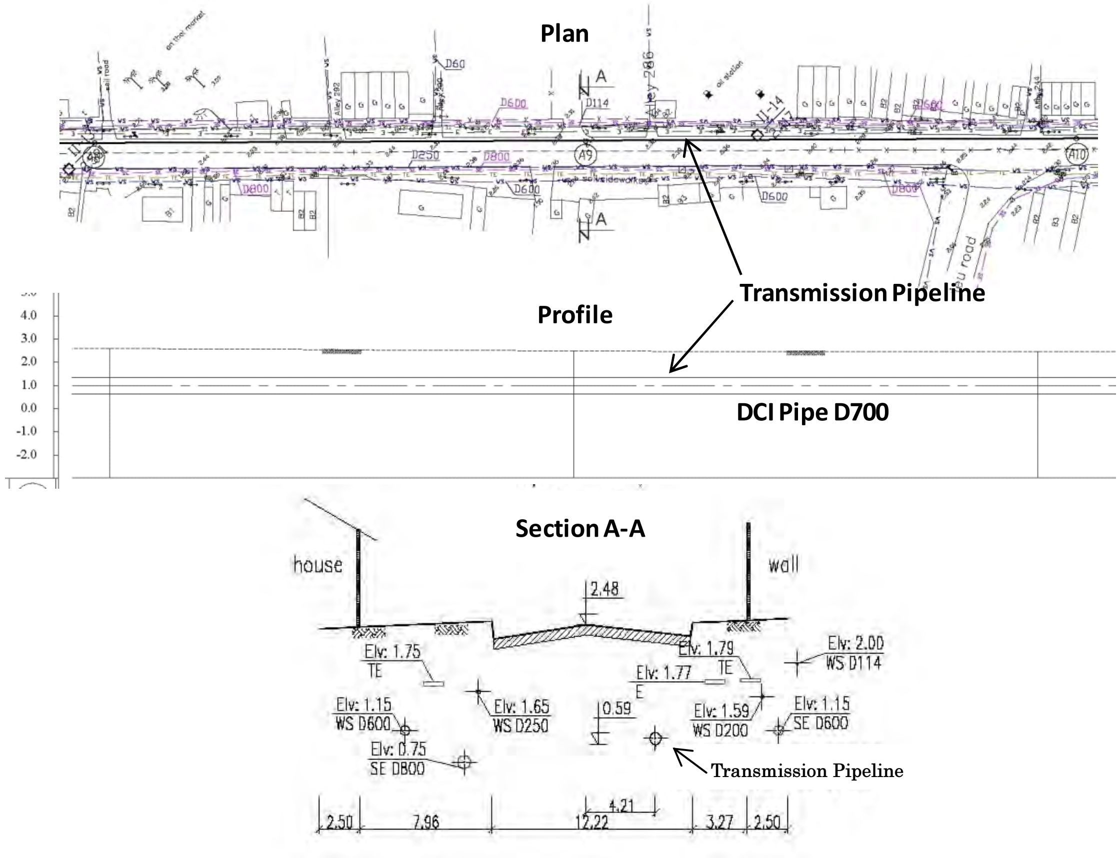
Figure 5.3.3 Typical Cross Section of the National Road

As shown in the above figure, it is difficult to install a new pipe under the sidewalk of the national road. Thus, a new transmission pipeline is planned to be installed under the edge of the roadway. It is noted that DOT has a plan of widening the national road, and the existing underground utilities are to be relocated. However, the plan is suspended due to the lack of budget.

5.3.3 Plan and Profile of the Transmission Pipeline

As mentioned above, the transmission pipe is planned to be located at the edge of the roadway, which is approximately 4 m to 5 m from the centerline of the road. According to the Vietnamese regulation, the earth coverage of the pipe is planned to be 1.2 m from the road surface, except in the case of crossing the existing underground utilities.

The plan and profile drawings of the pipeline are shown in Drawing PL-1/12 - 12/12. The typical layout of transmission pipeline is shown in Figure 5.3.4.



Note: TE: Telephone Line, WS: Water Distribution Pipe, SE: Sewer Pipe, E: Electrical Cable, Elv: Invert Elevation

Source: JICA Study Team

Figure 5.3.4 Typical Layout of Transmission Pipeline

5.3.4 Selection of Pipe Material

The comparison of pipe materials is carried out for the planned transmission pipeline. The comparison results are shown in Table 5.3.1.

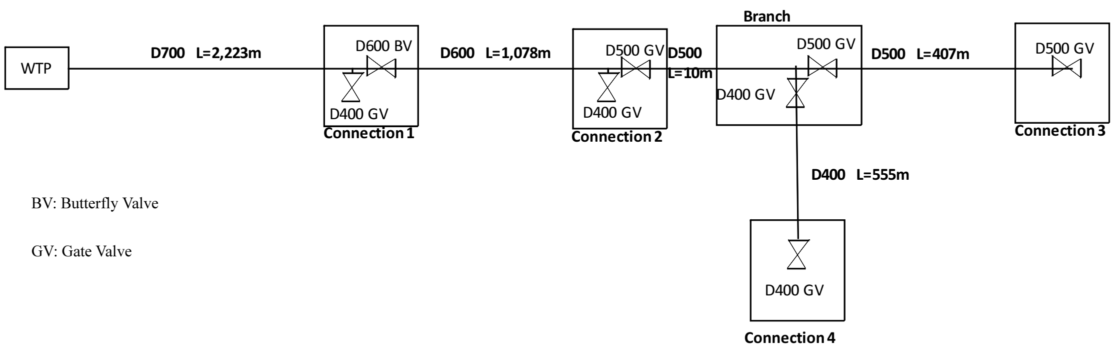
Table 5.3.1 Comparison of Pipe Materials

	DCI Pipe	Steel Pipe
Work efficiency	- High work efficiency - No need for special skill and equipment	- Needs special skill - Needs strict quality control - Difficult in wet condition
	◎	△
Material cost (DM 400)	VND 2,600,000/m	VND 1,600,000/m
	○	◎
Construction Cost (DM 400)	VND 1,200,000/m	VND 2,100,000/m
	◎	△
Durability	- High durability	- Needs measure to prevent electrical corrosion
	◎	△
General practice in WSSC	Applied in WSSC as a standard material for pipelines with diameter of 250 mm or larger.	Not generally used in Vietnam except for special locations such as high working pressure section, river crossing section, etc.
	◎	△
Overall judgment	◎	△

Source: JICA Study Team

5.3.5 Valve Facilities

Valve facilities are planned to be installed at the four connection points and branch point. Sluice valve is applied for valves with diameter of 500 mm or less. Butterfly valve is applied for valves with diameter of 600 mm. The schematic diagram of the valve locations is shown in Figure 5.3.5.



Source: JICA Study Team

Figure 5.3.5 Schematic Diagram of the Valve Locations

5.3.6 Flow Analysis

(1) Objective and Procedure of the Flow Analysis

A flow analysis of the distribution pipe network was conducted to check the effect of the inflow of large amount of water from the new water treatment plant on water pressure in the existing distribution network, to determine the connection point of the transmission pipeline with the existing distribution pipeline, and to assess the flow conditions after the completion of the construction works of the project.

The flow analysis was conducted using the following procedure:

1) Modeling of the existing distribution network

The flow analysis mode of existing distribution network is created from the data of existing pipe location, length, diameter, material, water demand, water supply volume from existing water treatment plant, water pressure, and valve location. The detailed procedure is shown in Appendix C.

2) Network calculation in existing distribution network

Distribution network calculation is carried out by water analysis software, "EPANET Ver2", and the water pressure in each distribution point is calculated.

3) Modeling of the future distribution network

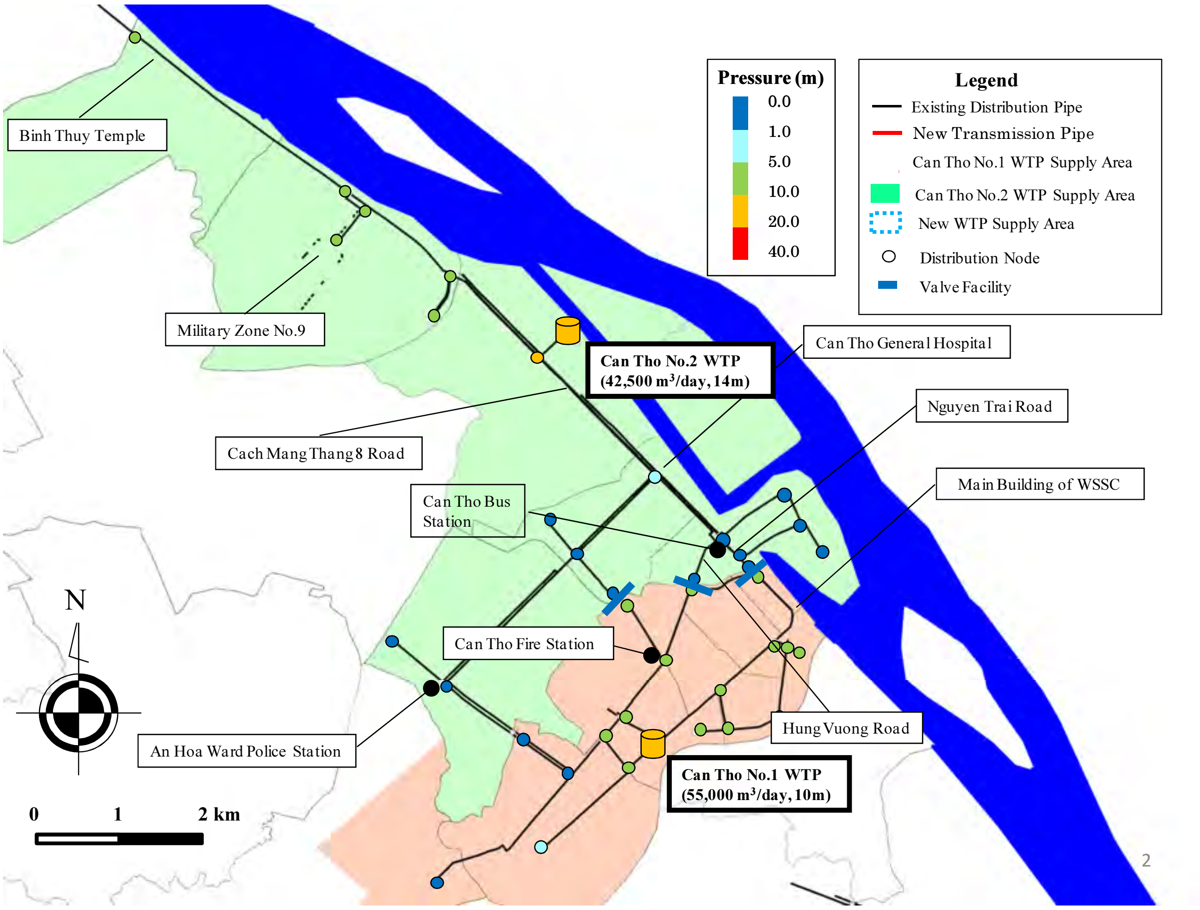
The flow analysis mode of the future distribution network is created from the data of planned distribution pipe location, length, diameter, material, water demand, water supply form planned water treatment plant, water pressure, and valve location.

4) Network calculation in future distribution network

The distribution network calculation is carried out by water analysis software, "EPANET Ver2", and the water pressure in each distribution point is calculated. The location of valve and connection point with minimal effect on water pressure in existing distribution network is determined by trial and error method.

(2) Flow Analysis in Existing Distribution Network

Figure 5.3.6 shows the result of flow analysis in the existing distribution network.



Source: JICA Study Team

Figure 5.3.6 Existing Situation in Existing Distribution Network

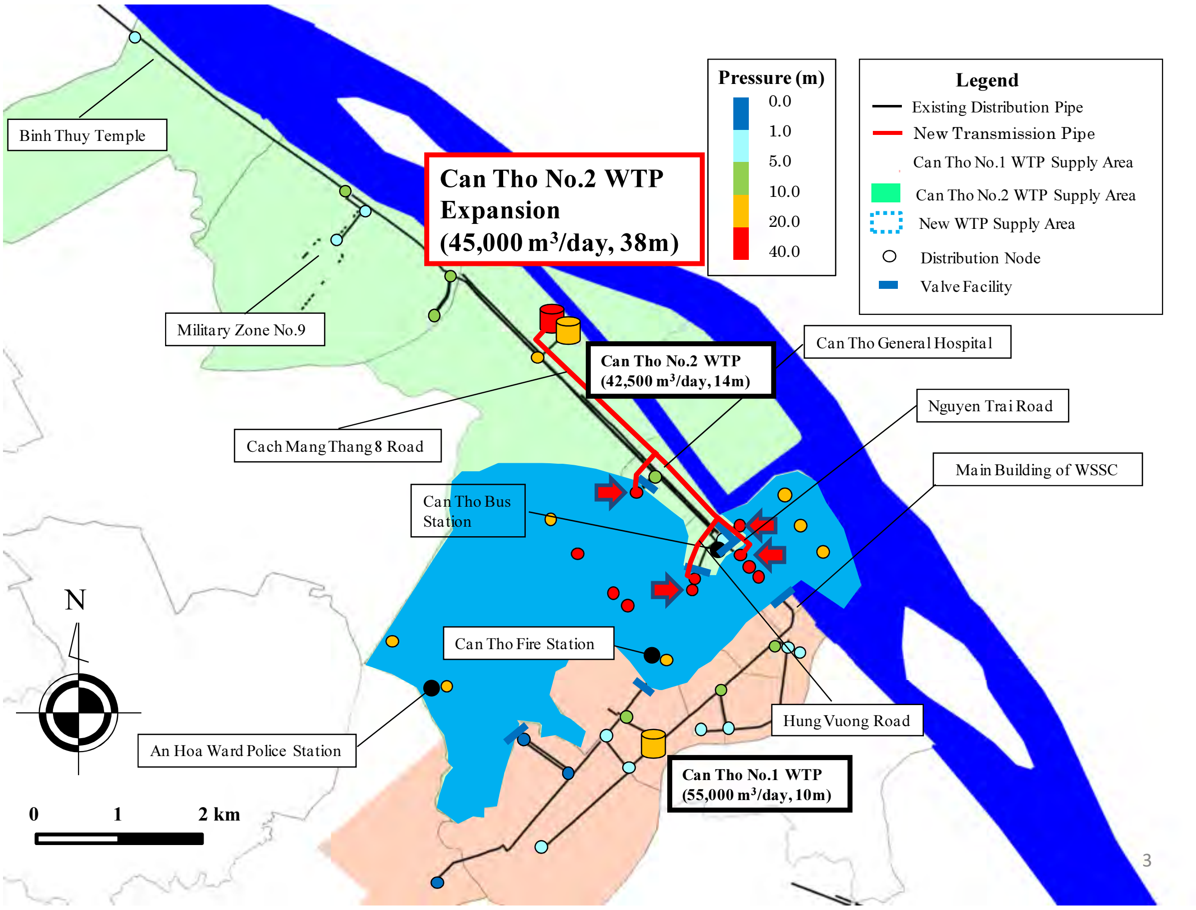
As indicated in the above figure, water pressure is less than 10 m in almost all networks, although the Vietnamese design standard prescribes the minimum water pressure in the distribution pipeline to be 10 m. Especially, the water pressures in the remote areas far from the existing water treatment plant do not reach 1 m.

(3) Flow Analysis in Future Distribution Network

Based on the results of flow analysis in the existing distribution network and future water demand projection, flow analysis in the future distribution network is carried out.

It is proposed that each water supply area of Can Tho No. 1 WTP, Can Tho No.2 WTP, and new WTP should be clearly divided by the installation of new valve.

Figure 5.3.7 shows the proposed division of the water supply areas and connection points with indication of the assessed pressure conditions.



Source: JICA Study Team

Figure 5.3.7 Future Situation in Planned Distribution Network

The above figure shows that the water pressure in the supply area of the new WTP is more than 10 m. On the other hand, the water pressure does not reach 10 m yet in areas remote from the existing WTP. The main cause of the low water pressure in the distribution network is the low water pressure of distribution pump in Can Tho No. 1 and No. 2 WTPs. Hence, it is recommended to increase the water pressure from the existing distribution pump.

CHAPTER 6 COST ESTIMATE AND CONSTRUCTION SCHEDULE

6.1 Cost Estimate

6.1.1 Project Facility

The project facility is composed of the following:

i) Intake and water treatment plant (WTP) with capacity of 45,000 m^3/day; and
ii) Transmission pipeline to deliver the bulk water from the WTP to the connection points on the existing distribution pipeline.

Table 6.1.1 shows the outline of the project facilities.

Table 6.1.1 Outline of the Project Facility

Facility	Outline
A. Intake Facility	Foundation: Pier foundation Pump house: RC & concrete block Intake pump: Vertical mixed flow, 16.5 m^3/min x 15 m x 60 kW, 3 nos. Electric chain hoist with motorized trolley, 3 tons
B. Water Treatment Plant	
Sedimentation Facility	Vertical up flow type with tube settler, 4 lines
Rapid Sand Filter	Self washing type, 8 nos., Siphon system Backwash blower: Roots type, 10.8 m^3/min x 60 kPa x 18.5 kW, 2 nos.
Clear Water Reservoir and Pump	Volume: 7,500 m^3, 2 lines Distribution pump: Vertical mixed flow, 24 m^3/min x 40 m x 220 kW, 3 nos. Service water unit: Horizontal centrifugal, 0.2 m^3/min x 25 m x 1.5 kW, 1 no. Electric chain hoist with motorized trolley, 3.5 tons
Sludge Treatment	Backwash wastewater tank: V=350 m^3 Wastewater discharge pump: Submersible, 1.25 m^3/min x 15 m x 5.5 kW, 2 nos. Sludge regulation tank: V=50 m^3 Sludge discharge pump: Progressive cavity, 0.23 m^3/min x 15 m x 0.75 kW, 2 nos.
Chemical Facility	PAC dosing system: Diaphragm type, 2.9 L/min x 0.75 kW, 2 nos. Chlorination system: 4 kg/h, 3 nos. Air compressor for valve actuator: 240 L/min x 0.83 MPa x 2.2 kW Electric chain hoist with motorized trolley, 1.5 tons
Electrical Facility	Power receiving panel, Local control panel, Instrumentation, Cables Emergency generator: 3 phase, 4 wire, 750 kVA
Sludge drying bed	10,000 m^2 (50 m x 50 m, 4 nos.)
C. Water Transmission Pipeline	
Pipeline	DCI Pipe D700 – D400, L = 4.3 km
Connection Point	4 nos.

Source: Study Team

6.1.2 Conditions of Cost Estimate

(1) Conditions of Project Cost Estimation

The project cost was estimated based on the following conditions:

1) Price level : May 2012
2) Exchange rate : JPY 1 = VND 266

(May 31, 2012 Vietcombank Selling Rate)

(2) Composition of Project Cost

The project cost is composed of capital cost (CAPEX) and operation and maintenance cost (OPEX).

1) Capital Cost (CAPEX)

The CAPEX is estimated by the following items, in accordance with the Ministry of Construction Circular No. 04/2010/TT-BXD dated May 26, 2010:

a) Construction cost : Cost for civil works and building works
b) Equipment cost : Cost for mechanical and electrical works
c) Compensation and resettlement assistance
: Cost for compensation and resettlement assistance to people affected by the project implementation
d) Project management cost : Cost for project management
e) Construction investment consultancy cost
: Cost for design and construction supervision
f) Other costs:
- Demining and removal of bombs and explosives;
- Work insurance;
- Mobilization of construction equipment to the construction site;
- Traffic safety assurance for the construction works;
- Reimbursement of infrastructures affected by construction works; and
- Some other costs necessary for the project implementation.
g) Physical contingency : 5% of Items a) to f)

2) Operation and Maintenance Cost (OPEX)

The OPEX is composed of the following:

a) Power cost;
b) Chemical cost;
c) Maintenance cost;
d) Personnel cost; and
e) Sludge disposal cost.

(3) Conditions of Construction and Equipment Cost Estimation

1) Construction Cost

The civil and building works will be executed by Vietnamese contractor. The labor, construction materials, and construction machines will be procured in Vietnam.

2) Equipment Cost

The mechanical and electrical equipment will be procured mainly from foreign suppliers/manufacturers. The import tax is not included in the cost estimate in accordance with Decree 108-2009-ND-CP on BOT Contract as amended by Decree 24-2011-ND-CP.

6.1.3 Capital Cost

(1) Construction Cost

1) Composition of Construction Cost

In accordance with Circular No. 04/2010/TT-BXD, the construction cost is composed of the items listed in Table 6.1.2.

Table 6.1.2 Composition of Construction Cost

Item	Content	Remarks
I. Direct Cost		
1) Direct construction cost	Cost of labor, construction materials, and construction machines	Based on the work volume determined from the detailed engineering design
2) Other direct cost	Protection of surrounding environment, care of water, etc.	2.5% of Item 1)
	Direct Cost	T = 1) + 2)
II. General Cost	Cost for construction site management	C = T x 6.5%
III. Advance Calculated Taxable Income	Overhead and profit of the contractor	TL = (T+C) x 5.5%
	Before-tax Construction Cost	G = T+C+TL
IV. VAT	Tax payable	GTGT = G x 10%
V. Cost for Construction Administration	Cost of temporary housing on site and construction administration	Gxdnt = G x 2% x 1.1
	Total	G + GTGT + Gxdnt

Source: Circular No. 04/2010/TT-BXD

2) Estimation of Direct Construction Cost

The cost is basically estimated using the work volume and the process/work unit cost. The process/work unit cost is composed of the basic prices which include the prices of labor, construction materials, and construction machines. The basic prices are listed in Table D1.1 of Appendix D. The process/work unit costs estimated based on the basic prices are shown in Table D1.2 and Table D1.3 of Appendix D.

3) Estimated Construction Cost

The estimated construction cost is shown in Table 6.1.3. The breakdown of the direct construction cost is shown in Table D1.4 of Appendix D.

Table 6.1.3 Construction Cost

Item	Cost (Million VND)	Note
I. Direct Cost		
Intake	[redacted]	
Water Treatment Plant	[redacted]	
Water Transmission Pipeline	[redacted]	
Other Direct Costs	[redacted]	2.5% of above
Direct Cost	[redacted]	T
II. General Cost	[redacted]	C = T x 6.5%
III. Advance Calculated Taxable Income	[redacted]	TL = (T+C) x 5.5%
Before-tax Construction Cost	[redacted]	G=T+C+TL
IV. VAT	[redacted]	GTGT=G x 10%
After-tax Construction Cost	[redacted]	G+GTGT
V. Cost for Construction Administration	[redacted]	G x 2% x 1.10
Total	[redacted]	

Source: Study Team

(2) Equipment Cost

In accordance with Circular No. 04/2010/TT-BXD, the equipment cost is composed of the following:

1) Cost for procurement of equipment;
2) Cost for training and technology transfer;
3) Cost for equipment installation, testing, and calibration; and
4) VAT.

The cost is estimated for major equipment, based on quotations from suppliers/manufacturers.

The estimated equipment cost is shown in Table 6.1.4. The breakdown of the cost for equipment procurement is shown in Table D1.5 of Appendix D. The equipment is to be procured mainly from foreign suppliers/manufacturers. Therefore, the cost is estimated in foreign currency (JPY).

Table 6.1.4 Equipment Cost

Item		Cost (Million JPY)
I.	Cost for equipment procurement	[redacted]
II.	Cost for training and technology transfer	(included in Item III)
III.	Cost for installing equipment and testing and calibration	[redacted]
	Total (Before Tax)	[redacted]
	VAT (10%)	[redacted]
	Total	[redacted]

Source: Study Team

(3) Breakdown of Construction Cost and Equipment Cost by Facility

The breakdown of construction and equipment costs is shown in Table 6.1.5.

Table 6.1.5 Breakdown of Construction Cost and Equipment Cost by Facility

		Construction Cost		**Equipment Cost**		**Total**	
		Billion VND	(Equivalent Million JPY)	Billion VND	(Equivalent Million JPY)	Billion VND	(Equivalent Million JPY)
A	**Intake (47,500 m^3/day)**	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
B	**Water Treatment Plant (45,000 m^3/day)**	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Sedimentation Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Sand Filter Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Distribution Reservoir and Pump Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Sludge Treatment Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Chemical Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Electrical Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Site Preparation and Ancillary Work	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
C	**Water Transmission Pipeline**	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Pipeline D700-D400 L=4.2 km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Connection point: 4 nos.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Source: Study Team

(4) Cost for Compensation and Resettlement Assistance

The land for construction of WTP and sludge drying bed will be provided with no charge by Can Tho PC. The transmission pipelines will be laid under the public roads. Thus, no cost for compensation and resettlement is estimated.

(5) Project Management Cost, Construction Investment Consultancy Cost, and Other Costs

In accordance with Circular No. 04/2010/TT-BXD, these costs have been estimated at 7% of the total of construction cost and equipment cost.

(6) Physical Contingency

For physical contingency, 5% of construction cost, equipment cost, cost for compensation and resettlement assistance, project management cost, construction investment consultancy cost, and other costs is allocated.

(7) Overall Capital Cost

Overall capital cost is shown in Table 6.1.6.

Table 6.1.6 Overall Capital Cost

JPY 1 = VND 266

	FC Portion (Billion VND)	LC Portion (Billion VND)	Total (Billion VND)	Total (Equivalent Million JPY)	
1. Construction Cost	[redacted]	[redacted]	[redacted]	[redacted]	including VAT
2. Equipment Cost	[redacted]	[redacted]	[redacted]	[redacted]	including VAT
3. Compensation and Resettlement Assistance	[redacted]	[redacted]	[redacted]	[redacted]	
4. Project Management					
5. Construction Investment Consultancy	[redacted]	[redacted]	[redacted]	[redacted]	7% of (1.+2.)
6. Other Costs					
7. Physical Contingency	[redacted]	[redacted]	[redacted]	[redacted]	5% of (1. – 6.)
Total Capital Cost	[redacted]	[redacted]	[redacted]	[redacted]	

Source: Study Team

6.1.5 Operation and Maintenance Cost

(1) Estimation Method

1) Power Cost

The electricity cost is estimated using the planned electric energy and unit price of electricity. In addition, the fuel cost for emergency generator is estimated by the average annual power failure hours.

2) Chemical Cost

The chemical cost is estimated by the planned consumption of chemical and unit price of the chemicals.

3) Maintenance Cost

The maintenance cost is estimated at around 1.3% of the initial equipment cost.

4) Personnel Cost

Personnel cost is estimated by the staff salary and office running cost. The projected number of staff is 30 (three shifts).

5) Sludge Disposal Cost

Sludge disposal cost is estimated by the planned sludge volume multiplied by the unit disposal cost. The hauling distance is set at 6 km.

(2) Operation and Maintenance Cost

Estimated annual operation and maintenance cost is shown in Table 6.1.7

Table 6.1.7 Annual Operation and Maintenance Cost

	Unit	Qty	Unit Cost (VND)	Amount (Billion VND)	Note
Power Cost					
Electricity	kWh	2,989,350	[redacted]	[redacted]	8,616 hour /year x 347 kW
Diesel oil	L	15,510	[redacted]	[redacted]	144 hour/year x 108 L/hour
			[redacted]	[redacted]	
Chemical Cost					
PAC (powder)	kg	288,228	[redacted]	[redacted]	Raw water: 15,038,000 m^3/year Dosing rate: 19.17 g/m^3
Chlorine (gas)	kg	66,467	[redacted]	[redacted]	Dosing rate: 4.42 g/m^3
			[redacted]	[redacted]	
Maintenance Cost					
Maintenance Cost	LS	1	[redacted]	[redacted]	1.37% of Equipment Cost
Personnel Cost					
Office running cost	month	12	[redacted]	[redacted]	
Manager	MM	36	[redacted]	[redacted]	3 persons x 12 months
Operator	MM	300	[redacted]	[redacted]	25 persons x 12 months
Guard	MM	24	[redacted]	[redacted]	2 persons x 12 months
Technical instructor	MM	1	[redacted]	[redacted]	Foreign
			[redacted]	[redacted]	
Sludge Disposal Cost					
Sludge disposal	ton	3,022	[redacted]	[redacted]	Dry sludge: 3,022 tons/year
			[redacted]	[redacted]	
			[redacted]	[redacted]	

Source: Study Team

6.2 Construction Schedule

The project is to be implemented under a BOT contract between Can Tho PC/WSSC and SPC established by investors. After the BOT contract is concluded, the construction work will be executed under an EPC contract between the SPC and EPC contractor.

It is expected that the EPC contract will be concluded in the middle of 2014. Then, the EPC contractor will prepare the detailed design. After the detailed design is approved, the EPC contractor will commence the construction works.

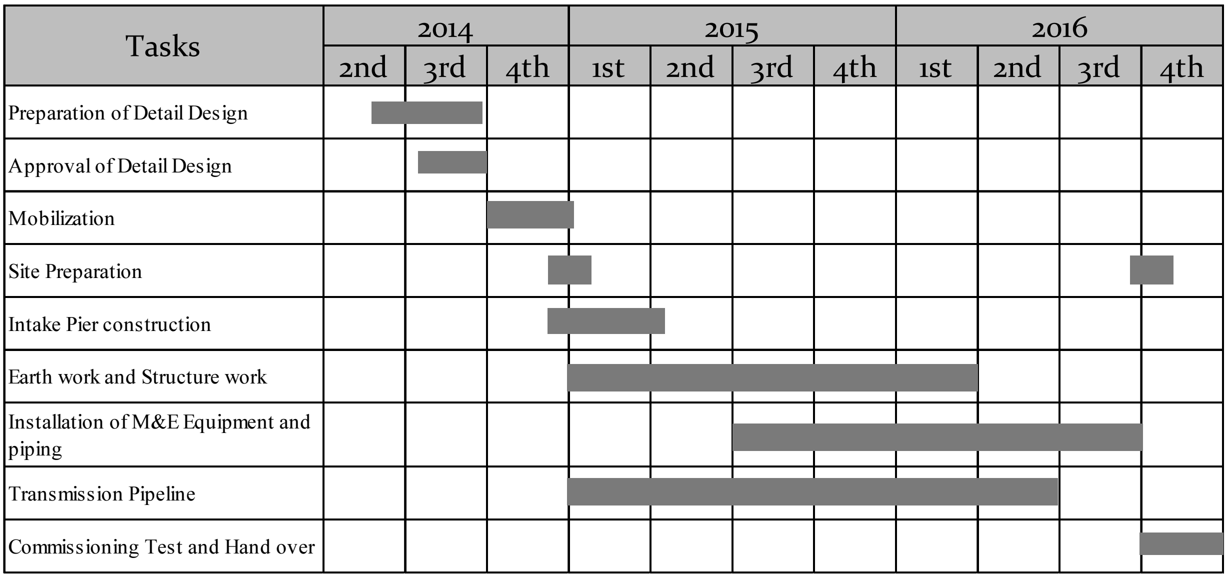
The construction work starts from mobilization followed by site preparation and intake pier construction. The civil works for the WTP and transmission pipeline are expected to commence in the beginning of 2015.

After construction work is completed, the commissioning test will be executed.

The total construction work period including detailed design and commissioning test is planned to be 32 months and is expected to be completed by the end of 2016.

The construction schedule is shown in Figure 6.2.1.

The annual disbursement of the construction cost is assumed to be 20% in 2014, 40% in 2015, and 40% in 2016.



Source: Study Team

Figure 6.2.1 Construction Schedule

CHAPTER 7 PROJECT IMPLEMENTATION PLAN

7.1 Overall Project Schedule

Figure 7.1.1 below outlines the overall schedule of this project, which contains the project development, construction, and O&M works.

The figure is omitted due to confidentiality.

Source: JICA Study Team

Figure 7.1.1 Overall Project Schedule

7.2 Detailed Schedule

7.2.1 Project Development Period

The project development period contains three phases: 1) Project Design; 2) Project Approval; and 3) Negotiations and Signing of Contracts. Figure 7.2.1 outlines the main tasks of each phase and their specific timelines.

The figure is omitted due to confidentiality.

Source: JICA Study Team

Figure 7.2.1 Project Development Schedule

(1) Project Design

During the "Project Design" phase, the Study Team or the potential investors will work on the feasibility study.

(2) Project Approval

In the "Project Approval" phase, JICA will review the draft report of the feasibility study and evaluate and make an initial judgment for possibility to utilize PSIF.

(3) Negotiations and Signing of Contracts

During the "Negotiations and Signing of Contracts" phase, the investors shall sign a shareholders' agreement to agree on the implementation of the project.

7.2.2 Construction Period

The construction period, which includes the detailed design and construction phases shall start in 2014. It will continue for three years until the commissioning by the end of 2016 (refer to Chapter 6.2 for details of the construction schedule).

7.2.3 O&M Period

The O&M period shall start in 2017 as shown in Figure 7.2.2. The operational period for this project is planned for 25 years, which will continue until 2041.

At the end of the operation, the SPC shall transfer the plant to WSSC without compensation in accordance with the procedures stipulated in the BOT Law (refer to Chapter 3.1.3 (4) for details of the procedures).

The figure is omitted due to confidentiality.

Source: JICA Study Team

Figure 7.2.2 O&M Schedule

CHAPTER 8 RISK ANALYSIS

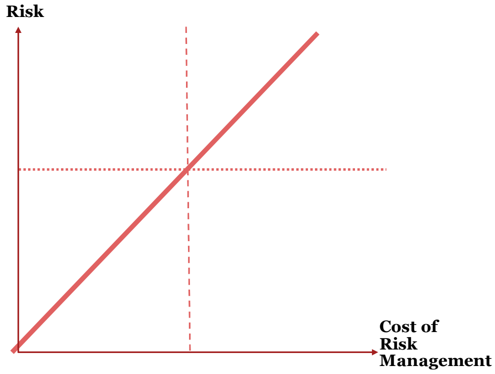
8.1 Risk Analysis and Designing Countermeasures

8.1.1 Risk Sharing

Designing appropriate risk sharing structure among related parties and mitigation measures to prevent risks from hindering the project are crucial in order to realize a feasible project. It is particularly important that each risk is borne by the party having the best ability to manage it.

The paragraph is omitted due to confidentiality.

Clear and well-balanced risk sharing benefits both the government and private enterprises by reducing project costs and also facilitating best efforts of each party to mitigate risks. Reduction of project costs will certainly be reflected in the price of their service fees, thus, benefitting the off-taker (usually public entity) of their services.



Source: JICA Study Team

Figure 8.1.1 Relationship of Risk Level and Risk Management Costs

8.1.2 Risks Generally Involved in BOT Infrastructure Projects

Risks needed to be considered in BOT infrastructure projects are caused by several factors such as commercial, financial, and external factors as indicated in Figure 8.1.2. When designing risk management structures for a project, one needs to consider each risk and determine how to share and mitigate them among the related parties.

Commercial Factors	Financial Factors	External Factors
・*Revenue Risks*	Risks related to…	Risks related to…
Risks related to…	-Obtaining finances	-Laws and regulations
-Off-take	-Sponsors	-Permits and licenses
-Sales price of services	-Currency exchange rate	-Socio-environment
-Currency exchange rate	-Interest rate	-Sovereign credibility
-Competitors		-Infrastructure
-Technology		-Sub-contractors
-Service demand		-Contracts
・*Expenditure Risks*		
Risks related to…		
-Inflation		
-Currency exchange rate		
-Facility design		
-Construction		
-O&M		
-Land preparation		
-Compensation		

Source: JICA Study Team

Figure 8.1.2 Generally Considered Risks for BOT Projects by Risk Factors

8.1.3 Expected Risks and Risk Management Methods for the Proposed Project

Table 8.1.1 shows a matrix of risks expected in the proposed project and the risk management methods for each of these risks. The matrix also indicates the applicability of insurances to cover each risk and the major insurances often utilized in BOT business are explained in the following pages.

Table 8.1.1 Risk Matrix

<Use of Insurance>

○: The insurance is expected to cover entire costs incurred

△: The insurance is expected to cover partial costs incurred

<Responsible Parties>

○: responsible parties for each risk.

△: parties that will burden remaining costs after insurance was paid for

*Government means Government of Vietnam or Can Tho People's Committee (Can Tho PC)

**Can Tho PC is expected to be indirectly responsible for those risks that are borne by the off-taker.

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

Source: JICA Study Team

The following are the major insurances often obtained in BOT projects:

(1) Overseas Investment Insurance

The overseas investment insurance mentioned in the matrix is provided by Nippon Export and Investment Insurance (NEXI). This insurance covers losses suffered by a Japanese company with a joint venture (the SPC) in a foreign country. Losses are covered when the SPC is forced to discontinue business due to war, terrorism, or force majeure, such as a natural disaster. In addition, it also covers losses incurred when a Japanese company is unable to remit dividends to Japan due to prohibition of foreign currency exchange or suspension of remittance. However, it does not cover commercial risks for which the counterparts of overseas transactions are responsible (e.g., SPC cannot collect revenue due to financial troubles of the counterpart such as WSSC or Can Tho PC for this project).

(2) Delayed Start-up Insurance

Delayed start-up insurance is provided by various insurance companies, and its conditions and coverage may vary depending on the provider. Generally, it covers the lost profit incurred as a result of damages made to the facilities during the construction period.

(3) Construction Insurance

Construction insurance is provided by various insurance companies, and its conditions and coverage may vary depending on the provider. Generally, it covers the entire costs incurred as a result of damages made to facilities, people, and/or other assets at the construction site due to unexpected events, such as accidents or natural disasters.

(4) Contractor’s Liability Insurance

Contractor’s liability insurance is provided by various insurance companies, and its conditions and coverage may vary depending on the provider. Generally, it covers the entire costs incurred as a result of damages made to facilities, people, and/or other assets related to the execution of the contract.

(5) Third Party Insurance

Third party insurance is provided by various insurance companies, and its conditions and coverage may vary depending on the provider. Generally, this insurance is designed to cover specifically either construction period or O&M period. This means that single insurance does not cover the entire project period. Insurance for construction and O&M period must be obtained separately. It covers the entire costs for compensation payments claimed by third parties when the construction or O&M works of the project are responsible for damages made to third parties.

8.2 Possible Project Scheme

8.2.1 Related Parties and Roles

In this study, the following parties are assumed to be involved in the project: (1) Can Tho City; (2) Off-taker; (3) Sponsors/SPC; (4) Lenders (financial institutions); (5) Insurance providers; and (6) Sub-contractors. Preliminary assumptions of role sharing among these parties are described below.

(1) Can Tho City

Can Tho City refers to municipality authorities such as Can Tho PC, DOC, DPI, DONRE, DOF, and DOST.

These municipality authorities will evaluate and approve the project plan and feasibility study report, and select investors. They will also propose detailed conditions for the project, including the wholesale price of water, and negotiate with selected investors on the details of the project contract. The project contract, or the BOT contract, will likely be signed between Can Tho PC and the SPC. They are also expected to issue the permits and licenses required for the SPC to start the water supply BOT business in Can Tho City.

(2) Off-taker

Off-takers are parties who purchase services from the SPC. In this project, WSSC might be the possible off-taker to purchase the treated water from the SPC. The WSSC's role to collect water tariffs from the residents does not change in this project scheme.

(3) Sponsors/SPC

Sponsors or the investors of the project will be the shareholders of the SPC. These sponsors would sign the shareholders agreement which stipulates their equity sharing, management structure of the SPC, as well as the actions required from each shareholder in case of disputes, financial default, and other unusual events.

The paragraph is omitted due to confidentiality.

(4) Lenders (Financial Institutions)

The SPC and financial institutions will sign the loan agreements for the long-term loans required for the project. In case Japanese investors are selected as project sponsors, JICA will provide their PSIF loans. The PSIF would be provided either directly or through the local financial institutions to the SPC. (See Chapter 9 for details of the PSIF loans.)

(5) Insurance Providers

The SPC/sponsors and insurance providers will sign an insurance purchase agreement for insurances to cover the various risks associated with the project. In case Japanese investors are selected as project sponsors, they have an option to purchase investment insurances provided by NEXI. The NEXI's insurance covers a wide scope of risks, including political risks, which may not be covered by typical insurances provided by private insurance companies.

(6) Sub-contractors

The SPC will sign the EPC and O&M contracts with the sub-contractors.

The paragraph is omitted due to confidentiality.

8.2.2 Organization of the Possible Project Scheme

The organizational structure of the possible project scheme with related parties and their roles and relationships introduced in Section 8.2.1 is presented in Figure 8.2.1. The PSIF loan is tentatively assumed to be provided directly to the SPC.

The figure is omitted due to confidentiality.

Source: JICA Study Team

Figure 8.2.1 Possible Project Scheme

8.3 Terms and Conditions of the Related Contract

8.3.1 BOT Contract

A summary of the major contents of the BOT contract stipulated in Circular No. 03/2011/TT-BKHDT is provided in Table 8.3.1. (For the full contents provided in the circular, see Appendix B2.7.) Also, the conditions (e.g. risk sharing, guarantees, etc) expected by currently planned Japanese investors as well as important points to be generally considered are indicated as "Remarks" for each item.

Table 8.3.1 General Contents of BOT Contract

The table is omitted due to confidentiality.

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The table is omitted due to confidentiality.

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The table is omitted due to confidentiality.

Source: JICA Study Team

8.3.2 EPC Contract

Table 8.3.2 shows the major contents generally required under an EPC contract in BOT infrastructure projects. Also, important aspects of this project as well as important points to be generally considered are indicated as "Remarks"

Table 8.3.2 General Contents of an EPC Contract

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

Source: JICA Study Team

8.3.3 O&M Contract

Table 8.3.3 shows the major contents generally required under an O&M contract in BOT infrastructure projects. Also, important aspects of this project as well as important points to be generally considered are indicated as "Remarks".

Table 8.3.3 General Contents of an O&M Contract

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

Source: JICA Study Team

8.3.4 Shareholders' Agreement

Table 8.3.4 shows the major contents generally required under a shareholders' agreement in

BOT infrastructure projects. .Also, important aspects of this project as well as important points to be generally considered are indicated as "Remarks" for each item.

Table 8.3.4 General Contents of a Shareholders' Agreement

The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

Source: JICA Study Team

8.3.5 Off-take Contract

Table 8.3.5 shows the major contents generally required under an off-take contract in BOT infrastructure projects. Also, the conditions (e.g. risk sharing, guarantees, etc) expected by currently planned Japanese investors as well as important points to be generally considered are indicated as "Remarks" for each item.

Table 8.3.5 General Contents of an Off-take Contract

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The table is omitted due to confidentiality.

The table is omitted due to confidentiality.

Source: JICA Study Team

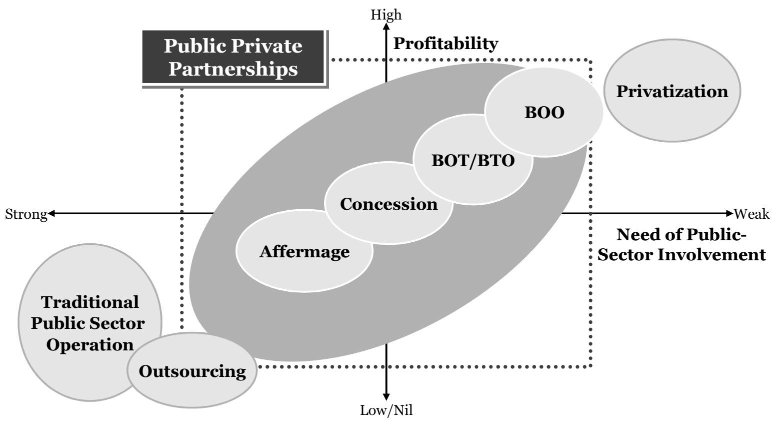
CHAPTER 9 PROJECT MODEL SCHEMES

9.1 Introduction of Public-Private Partnerships for Public Investment

From a global perspective, countries in need of capital investment have adopted public-private partnerships (PPP) scheme to bridge the growing gap between the cost of the infrastructure needed and the resources available, and to ensure that the infrastructure is delivered as efficiently and cost-effectively as possible. The PPPs are forms of cooperation between the public and private sectors for the funding, construction, renovation, management, or maintenance of an infrastructure or the provision of a service.

The term "public-private partnership" has been in general use since the 1990s in Europe. However, there is no widely agreed, single definition or model of PPP. It covers a range of different structures, as indicated in Figure 9.1.1, where the private sector delivers a public project or service.

The key contrast between PPP and traditional procurement is that in the former, the private sector's revenues during the contract period increase or decrease depending on the performance of the facility and quality of their goods/services. The private service provider is responsible not just for asset delivery, but for overall project management and implementation, and successful operation for several years thereafter. As a result, private firms can be more motivated in PPP to achieve performance requirements than in the traditional project scheme.



Source: JICA Study Team

Figure 9.1.1 Various Models of Public-Private Partnerships

9.1.1 Variations of Public-Private Partnerships

The PPPs cover a range of different structures where the private sector delivers a public project or service. The awarding agency of the project should consider the appropriate scheme based on the profitability of the project and necessity of public sector involvement. The build-own-transfer (BOT) and concession schemes are preferred in the water sector from the point of public interest because high service outcomes and performance, and cost-effectiveness could be expected under these schemes. However, the BOO scheme is much preferred to secure higher public interest leaving the right to make a decision on tariff level to the host government.

(1) Build-Own-Operate (BOO)

The BOO is a scheme which combines private finance, design, and construction with private operation after project completion. Operation and ownership of the project is usually continued with no transfer back to the government. Thus, in a BOO scheme, the project remains with the private sector without the requirement of transfer to the host government, and therefore very close to the free market ideal. Under this scheme, the private entity is allowed to recover its total investment, operation and maintenance costs plus a reasonable return by collecting fees and other charges from facility users.

(2) Build-Operate-Transfer (BOT)

The BOT scheme, which will be adopted in this proposed project, also involves a private sector design, construction, operation, and finance of infrastructure project. However, unlike in BOO, ownership of the project does not rest in the private sector. The host government has relatively strong right to control the service quality, since the host government is in charge of the payment for construction and operation of the private sector entity based on its performance. Thus, this scheme has the merit to secure the service quality to be provided by the private sector entity. The private sector entity is given the operational rights to the project for an agreed period of time, during which the private entity is expected to recover the project investment, operation and maintenance costs, and a reasonable profit from the project revenues. The important difference is that the project has to be transferred back to the host government at the expiry of the agreed period of time.

(3) Build-Transfer-Operate (BTO)

The BTO scheme also involves a private sector design, construction, operation, and finance of infrastructure project. However, unlike in BOT, the private sector entity shall transfer the project assets after project completion. The cost and some profit for the construction of the project assets shall be paid by the host government without relation to its operational performance. The private sector entity is given the operational rights to the project for an agreed period of time, during which the private entity is expected to recover the project investment, operation and maintenance costs, and a reasonable profit from the project revenues.

(4) Concession

Concession scheme also involves a private sector design, construction, operation, and finance of infrastructure project. However, unlike in BOT, the private sector entity is given the rights of direct fare collection from end users for an agreed period of time. Borrowing for capital investment by the private sector entity shall be repaid with collected fare. After the expiration of the project period, the project has to be transferred back to the host government.

(5) Affermage

The affermage scheme involves only a private operation, and the private sector entity is given the rights of direct fare collection from end users for an agreed period of time. Unlike in concession, the host government shall construct the necessary facilities. After the expiration of the project period, the project has to be transferred back to the host government.

The characteristics of each of the PPP structures are summarized in Figure 9.1.2.

▼Proposed Scheme

	Traditional procurement	*Affermage*	BTO	Concession	BOT	BOO	*Privatization*
Ownership	*Public*	*Public*	*Public*	*Public*	***Public****	Private	Private
Financing	*Public*	*Public*	Private	Private	Private	Private	Private
Operation	*Public*	Private	Private	Private	Private	Private	Private
Accountable for service provision**	*Public*	*Public*	*Public*	*Public*	*Public*	*Public*	Private

Private Involvement/ Project Profitability: Low ⟷ High

* Private sector has ownership during the contract period and transfers it to public after the expiration of the contract.
**Sets level of quantity and standard of service quality

Source: JICA Study Team

Figure 9.1.2 Categorization of Role of Public and Private Sectors

9.2 Financing Scheme

The profitability of a project is strongly related to its financing scheme because the profit arising from the project is the source for the repayment. Generally, the project with low profitability needs long term financing, while the project with high profitability needs short term financing.

The paragraph is omitted due to confidentiality.

When an appropriate scheme is considered, it would be essential to consider it from the viewpoint of "how it will be funded" since (if we consider the size of the initial investment amount) this project cannot be implemented without securing financing source.

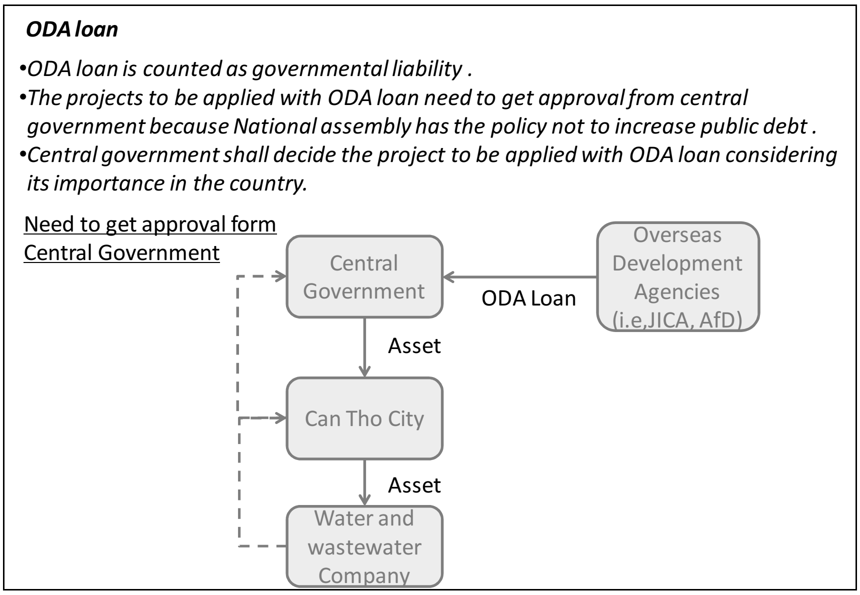
9.2.1 Financing Source Options

To fund the initial investment of the plants, the following can be the possible financial sources:

(1) Official Development Assistance (ODA) Loan

The ODA is a long term loan provided by foreign governments or by multilateral support organizations. The borrower of ODA loan is in principle limited to governments.

Since this report discusses the possibility of obtaining financing from the Japanese government, the ODA loan from JICA shall be assumed for this option. The characteristics of this case are summarized in Figure 9.2.1.



Source: JICA Study Team

Figure 9.2.1 Outline of ODA Loan

(2) PSIF Loan by JICA (Long-Term Project Financing)

As a second alternative, the long-term project financing in which the lender will take (not all but certain) commercial risks of the project shall be considered.

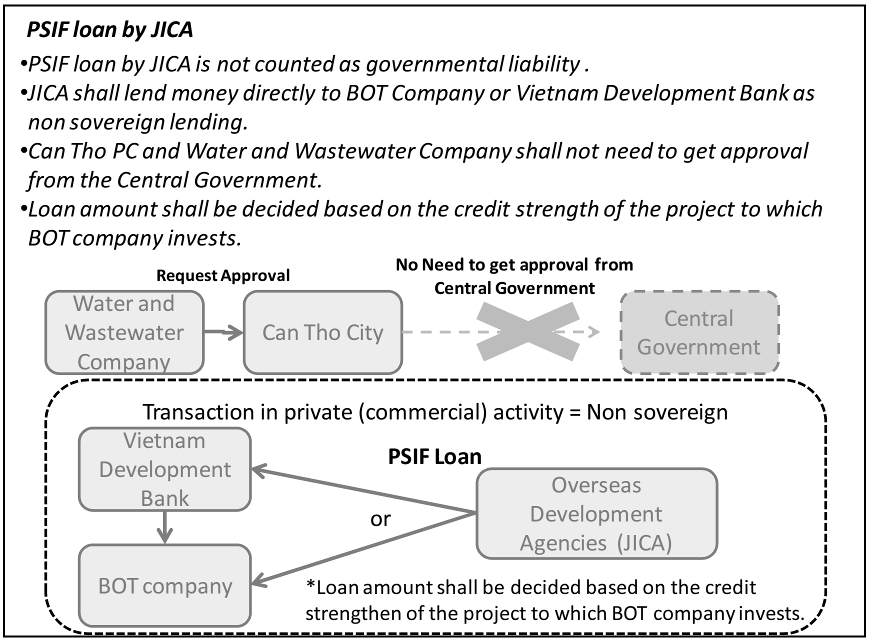
JICA restarted its PSIF program from 2011. Under this program, JICA shall provide long-term loan or make equity investment to private sector entities.

The maximum tenor of the loan is said to be 25 years with 10 years grace period.

The JICA may provide PSIF financing to local banks (e.g., in Vietnam), which will provide financing to the private sector entities. This scheme is called the two-step loan. In this two-step loan scheme, the currency of the loan to be provided by the local bank may be the local currency.

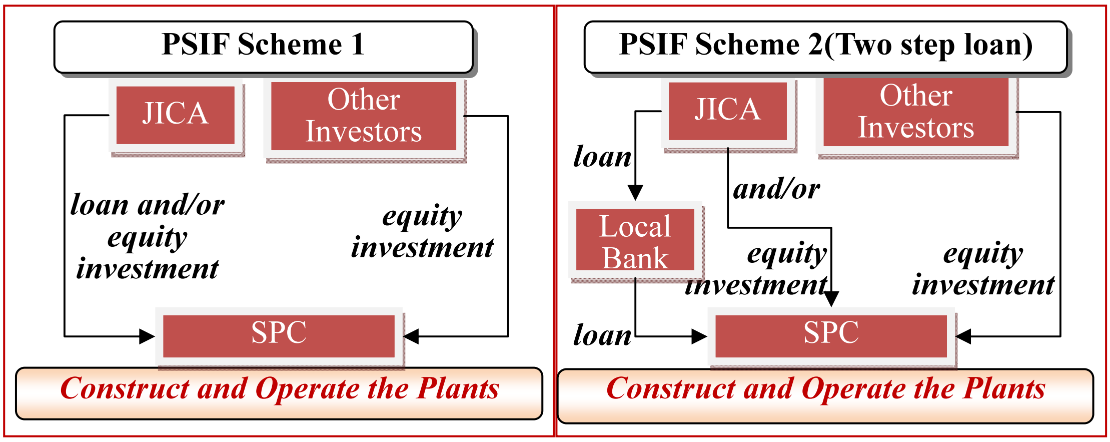
If PSIF is used to fund the initial investment of the project, an SPC to construct and operate the project needs to be established and this SPC shall obtain financing and/or equity investment under the PSIF scheme. Figure 9.2.2 and Figure 9.2.3 illustrate the two schemes under which PSIF shall be provided.

The BOT scheme (or other PPP scheme) shall be the prerequisite of this option, under which scheme, the WSSC will execute a long term project agreement with SPC, and under this agreement, the SPC shall design, build, finance, operate, and maintain the plant.



Source: JICA Study Team

Figure 9.2.2 Outline of PSIF Loan by JICA



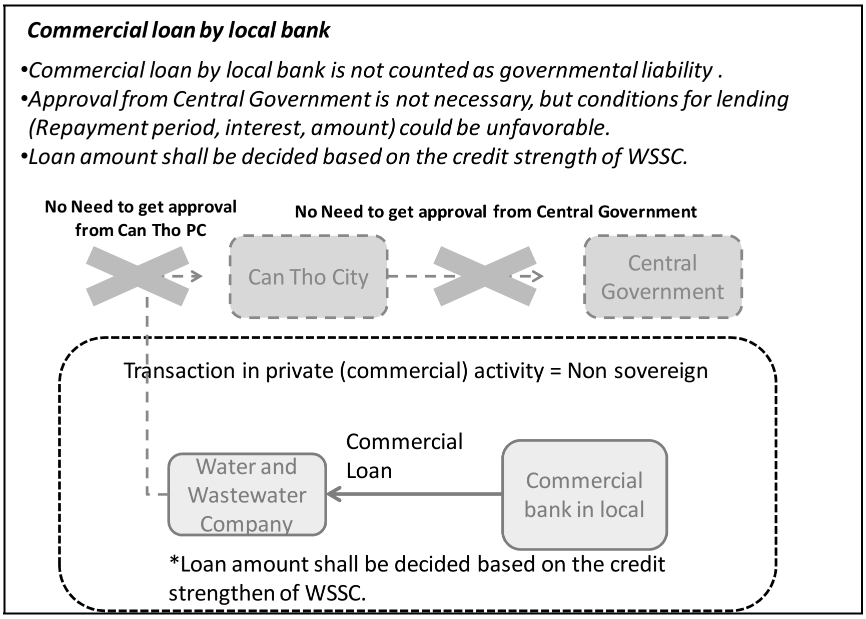
Source: JICA Study Team

Figure 9.2.3 Two Sub-schemes of PSIF

(3) Commercial Loan by Local Bank (WSSC's Own Borrowing)

The third possibility is that WSSC will borrow money for the initial investment of the plant from foreign or domestic banks, or other investors. In this option, such foreign or domestic banks or investors are supposed to be repaid money from not only the cash flow of the operation of the newly constructed plant, but also from other cash flows which WSSC shall generate from other businesses or investments.

To simplify the analysis, we assume that the lenders will be domestic banks in this option, since WSSC at this point in time does not borrow money from foreign banks/investors.



Source: JICA Study Team

Figure 9.2.4 Outline of Commercial Loan by Local Bank

9.2.2 Consideration on Financing Source Options

Table 9.2.1 illustrates the comparison of the possible financing source options. In the table, we tried to evaluate item by item the features of each financial source and put the colors for each item according to the following criteria, from the viewpoint of favorability to the project. It should be noted that PSIF is divided into two categories, namely, direct lending and two-step loan, as shown in Figure 9.2.3.

Based on the current evaluation, ODA loan could be regarded as one of the most favorable financing sources, since: i) it could be provided with very long tenor and low interest rate, and ii) it may be the most common source for Vietnamese government to fund infrastructure projects.

On the other hand, project financing under the PSIF program could also be regarded as another favorable financing source. In particular, it is favorable in that its preparatory steps do not take such a long time compared to ODA loan.

Considering the time frame, it is fair to evaluate at this point in time that project financing under the PSIF program would be the most favorable financing source option. The choice between the two sub-options (direct lending and two-step loan) should be analyzed at a later stage when the detailed financial conditions are clarified.

Table9.2.1 Comparison of Possible Financing Source Options

Financial Source	ODA Loan	Long Term Project Financing		WSSC's Own Borrowing (From Domestic Banks)
		PSIF (Direct Lending to SPC)	PSIF (Two-Step Loan)	
Tenor	Very Long (max: 40 years)	Long (max: 25 years)	Long (max:25 years but depending on the local bank)	Medium/Short (may be much shorter than the life of the project)
Currency of Loan	JPY	JPY	VND	VND
Interest Rate	Very Low	Low	Medium/High	High
Availability	Subject to priority of the project by Vietnamese government	Available as long as economically viable	Available as long as economically viable and acceptable by local bank	May take longer time to find banks
Time Frame	Will take long time	Will take medium time	Will take medium time	Will take short/medium time
Other Remarks	The loan constitutes the debt of the Vietnamese government			

Source: JICA Study Team

Remarks:
* Data for "ODA loan" is from JICA's homepage *
* The above data are just estimates from the current financial market and shall change through time. It is not certain that one can secure financial sources based on the conditions above.
* The colors in each item mean the following (based on our "trial" base evaluation):

Most favorable	Favorable	Neutral/Unable to evaluate	May not be favorable

9.3 Other Assumptions

(1) Tax Assumptions

1) Income Tax

Payable amount of enterprise income tax for each operational year is assumed as follows based on the incentive mechanism explained in Chapter 3.1.3 (5):

1^{st}~4^{th} year:	**0%**
5^{th} ~9^{th} year:	**5%**
10^{th} ~15^{th} year:	**10%**
16^{th} year and after:	**25%**

The loss incurred after the calculation of income tax for a fiscal year shall be carried forward to the next five years to be set off against the taxable income of each year.

2) Customs

Customs are exempted, as stated in the BOT Law Article 38.

3) VAT

Since VAT for water business is reduced to 5% (regular rate is 10%), the VAT received can be lower than the VAT paid.

(2) Fee

1) Right of Water Use

The law regulating royalty fee is currently under revision and the Study Team reviews the details.

2) Fee for Land Use

Fee for land use is exempted under the BOT law and is not included in the analyses, as stated in BOT Article 38.3.

(3) Deposit on Construction Completion (BOT Law Article 23)

-Investment amount of up to VND 1.5 trillion, maximum of 2% of the investment amount

-Investment amount of over VND 1.5 trillion, maximum of 1% of the excess investment amount

When tax refund is delayed by 3 months, the cost shall increase by an amount equal to: interest rate * number of years from signing of project agreement to construction completion * VND 87.4 million * approximately 1%.

(4) Inflation

The paragraph is omitted due to confidentiality.

(5) Currency Devaluation

The paragraph is omitted due to confidentiality.

(6) Depreciation

For accounting and tax calculation purposes, the construction cost and replacement cost are assumed to be booked as fixed assets at the completion of construction and replacement, and to be depreciated over the remaining years of the project period, so that the fixed assets so booked at the end of the project period becomes zero.

9.4 Project Organization

9.4.1 Organization of the SPC

The SPC is expected to take the form of either a limited liability company or a joint-stock company. According to the Law on Enterprise (Law No. 60/2005/QH11), limited liability companies and joint-stock companies are required to have management structures. The detailed functions of each management body shall be stipulated in the company's charter. Table 9.4.1 presents the required management structures by company type with their corresponding major functions.

Table 9.4.1 Management Structures by Company Type

Company Type	Required Management Structure	Major Functions
Limited Liability Company	1) Members Council	The highest decision-making body of a company. It makes decisions related to the company's strategy, business plans, benefits for director/general director, and other management issues.
	2) Chairman of the Members Council	A chairman shall be appointed by the members council. He/she organizes the preparation of agenda/materials for the council meetings, signs on behalf of the council its decisions, and supervises implementation of these decisions.

	3) Director or General Director	The director/general director shall be appointed by the members council. He/she implements decisions of the members council and decides on matters related to day-to-day business operations of the company.
	4) Control Board (for a company with 11 or more members)	The control board's roles and obligations shall be provided in the company's charter (The Law on Enterprise does not provide specific explanations on its functions).
Joint-Stock Company	1) Shareholders' Meeting	The highest decision-making body of a company. It makes decisions related to types/total numbers of shares, electing/dismissing members of the management board and control board, approval of annual financial statements, etc.
	2) Management Board	The management body of the company is authorized to decide the company's strategies, business plans, organizational structure, sales of shares, and other management issues that do not fall under the responsibilities of the shareholders' meeting. It also supervises the director/general director in managing day-to-day business activities.
	3) Chairman of the Management Board	A chairman shall be appointed by the shareholders' meeting or the management board. He/she may hold the post of director/general director at the same time, unless otherwise provided in the charter. He/she organizes the preparation of agenda/materials for the board meetings, arranges for the adoption of decisions by the board meetings, and supervises implementation of those decisions.
	4) Director or General Director	The director/general director shall be appointed by the management board. He/she implements decisions of the management board and decides on matters related to the day-to-day business operations of the company.
	5) Control Board (for a company with more than 11 individual shareholders or a shareholding	The members who are completely independent from the members of the management board/director/general director in order to

	organization which holds more than 50% of total shares)	supervise and verify the management and direction of the company led by the management board and the director/general director.

Source: Created by JICA Study Team based on the Enterprise Law (Law No. 60/2005/QH11)

In both limited liability company and joint-stock company, the company's representative-at-law must permanently reside in Vietnam. In case the representative is absent from Vietnam for more than 30 days, he or she must authorize in writing another person to exercise the rights and perform duties as the legal representative. In case of a limited liability company, either the chairman of the members' council, director, or general director shall be the representative-at-law. In case of a joint-stock company, either the chairman of the management board, director, or general director undertakes the duty. It is possible for Japanese staffs to undertake the positions other than the representative-at-law in the SPC.

9.4.2 Operational Plan

(1) Fundamental Policy of the Operational Plan

The O&M company shall operate and maintain the facilities that cleanse the water from the water source It is important to keep measuring the quality and the volume of the water flow that largely changes daily, weekly and/or seasonally and to make necessary adjustments and maintenances for the facility to keep up with those changes. The fundamental policy for the operation is to maintain stable water supply by designing manuals for such adjustments and maintenance works. Also, methods for operating in unusual occasions, such as unusual water pollutions and floods, are also necessary to be established. In order to preserve the facility in good condition for a long term, appropriate inspections and maintenance will be regularly conducted. The goal is to establish such operation, inspection, and maintenance procedures that are suitable for Vietnam and facilitate transfer of technologies and knowledge to the country.

(2) Business Contents

The paragraph is omitted due to confidentiality.

The paragraph is omitted due to confidentiality.

(3) Organization of O&M Works

1) Fundamental Organization

The paragraph is omitted due to confidentiality.

The figure is omitted due to confidentiality.

Source: JICA Study Team

Figure 9.4.1 Organization of the O&M Company

2) Roles of Each Department

The paragraph is omitted due to confidentiality.

(4) Supports

Table 9.4.2 shows the expected supports for the operation office of the water treatment plant. The currently planned Japanese O&M operator has local office with technical staffs so that they could offer labors or equipments to the operation office in case of emergency.

Also, the O&M operator has highly skilled labor in the field of inspection and maintenance in their headquarter office which can also provide technical supports where it’s necessary.

Table 9.4.2 Expected Supports for the Project

The table is omitted due to confidentiality.

Source: JICA Study Team

The manning for each operational year is scheduled as shown in Figure 9.4.2.

The figure is omitted due to confidentiality.

Source: JICA Study Team

Figure 9.4.2 Manning Schedule for the O&M Company

CHAPTER 10 FINANCIAL ASSESSMENT FOR PRIORITY SCHEME

10.1 Financial Plan for Priority Scheme

In this section, an analysis of the financial plan for priority scheme was made. Note that the analysis is calculated based on the conditions expected by those prospective investors in this study.

10.1.1 Assumptions on the Financial Analysis

The assumptions in the financial model consist of seven components, namely, 1) business plan (schedule and scope), 2) taxes, 3) financing, 4) initial development and construction cost, 5) operations and maintenance (O&M) cost, 6) revenues, and 7) reserve accounts. The currency used for calculation is Vietnamese Dong (VND).

(1) Business Plan Assumptions

1) Scheme

As proposed in Chapter 9, the project was assumed to be implemented by the BOT scheme, in which an SPC shall be established by private investors, and the SPC shall design, build, finance, operate, and maintain the plant in accordance with the project contract. In general, the O&M period is expected to be a long term stage under the BOT scheme or projects.

2) Schedule

The assumed schedule for the project is presented in Table 10.1.1.

Table 10.1.1 Project Schedule

Establishment of SPC	2013
Construction Commencement	2014
Completion of the Facility	2016
Commencement of Operations	2017
End of O&M Period	2041 (O&M period of 25 years)

Source: JICA Study Team

3) Outline of the Facility/Operating Ratio, etc.

The SPC shall develop the intake and water treatment plant (WTP) with a capacity of 45,000 m^3/day and the transmission pipeline for connecting the WTP and the existing distribution pipeline (Please refer to Chapter 6 for details). The WTP is expected to operate at full capacity from the first year of its operational period starting in 2017, but the expected average daily production volume is estimated at 39,000 m^3/day.

(2) Tax Assumptions

The value added tax (VAT) was assumed only for the construction costs. The income tax was assumed according to the tax rate described in Section 9.3. However, there was no assumption made for property tax.

(3) Financing Assumptions

1) Financing Source

The JICA's PSIF loan was assumed to fund 70% of the money required for the initial investment (initial budget including the payment for construction cost, interest during construction, etc.).

The other 30% of the initial budget was assumed to be funded by private investors in the form of equity.

2) Conditions of Loans

The conditions of each type of loan are shown in Table 10.1.2.

Table 10.1.2 Conditions of Loans

Type		PSIF Loan
Currency		JPY
Tenor	Disbursement	3 years
	Grace	2 years
	Repayment	20 years
	Total	25 years

Source: JICA Study Team

3) Equity IRR (EIRR)

The EIRR is defined as the internal return rate of annual profit (dividends) for sponsors compared to their initial equity investment in the SPC. The required level of EIRR varies depending on the investor's prerogative, yet in general it is set higher than the interest rate of loans, since the payment of the dividends is subordinate to the repayment for the loans.

The paragraph was omitted due to confidentiality.

(4) Initial Development and Construction Cost Assumptions

1) Construction Cost

The breakdown of the construction cost is shown in Table 10.1.3. (Please refer to Chapter 6 for details).

Table 10.1.3 Breakdown of the Construction Cost as of 2012

(VND in billions, JPY in hundred million)

The table was omitted due to confidentiality.

Source: JICA Study Team

The paragraph is omitted due to confidentiality.

2) Initial Development Cost

An assumed amount of the initial development cost will be used for the establishment of the SPC, SPC administration during construction period, and due diligence process, etc.

The paragraph is omitted due to confidentiality.

3) Interest during the Construction Period

The paragraph is omitted due to confidentiality.

(5) O&M Cost Assumptions

The paragraph is omitted due to confidentiality.

(6) Assumptions for Revenues

The SPC shall earn its revenue from tariff and interest income from cash deposit to reserve accounts, and the details are presented in Table 10.1.4.

1) Tariff Revenue

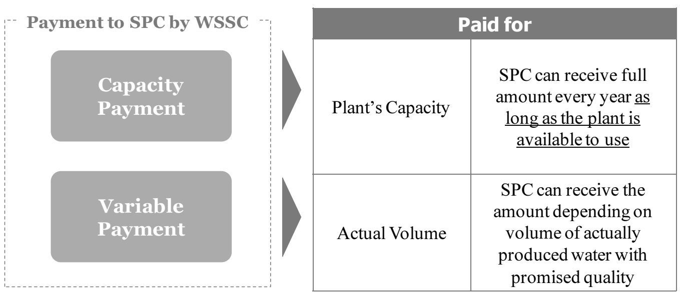
Table 10.1.4 Tariff Revenue

(VND in billions, Hundred million JPY)

The table was omitted due to confidentiality.

Source: JICA Study Team

The annual tariff revenues are calculated based on the payment formula of the "Take or Pay" method which is shown in Figure 10.1.1. The tariff price based on this formula consists of two components, namely, capacity payment and variable payments.



Source: JICA Study Team

Figure 10.1.1 Structure of the SPC's Revenue Formula "Take or Pay"

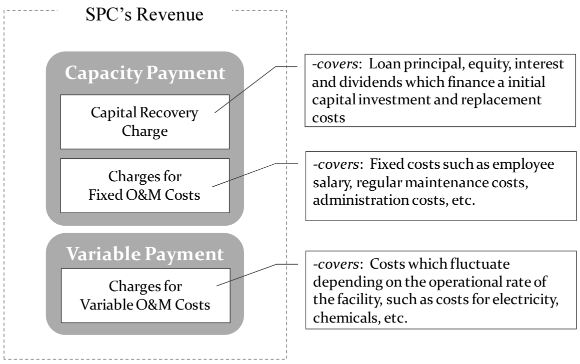
a. Background of Introduction

The "Take or Pay" method is popular and is being utilized worldwide for infrastructure projects with project finance. The payment formula reflects the allocation of risks, such as inflation, currency devaluations, etc., between the public and the private sector as agreed in the project agreement, and guarantees the revenue for the project company.

In the project finance, the revenue from the target project is the only source for loan repayments, unlike corporate finance, in which banks can request for loan repayments as long as borrowers maintain revenues regardless of financial condition of one particular project. This means that banks cannot offer project finances unless they are confident enough that the project is planned with appropriate risk allocation to ensure continuous realization of sufficient revenues. Thus, the project company intending to procure funds by way of project finance needs to plan appropriate risk allocations and determine such payment formula to comply with the allocation means. As a result, such payment formulas as shown Figure 10.1.1 are often required for project finances. .

b. Components of the Revenue

Under the abovementioned "Take or Pay" method, the capacity payment is composed of the capital recovery charge and charges for fixed O&M costs, while variable payment covers variable O&M costs as presented in Figure 10.1.2.



Source: JICA Study Team

Figure 10.1.2 Components of the SPC Revenue

c. Calculation Method

The tariff payment from WSSC to SPC shall be calculated as shown in Figure 10.1.3.

The table was omitted due to confidentiality.

Source: JICA Study Team

Figure 10.1.3 Formula of the SPC Revenue

The capacity payment is paid based on the plant's available capacity to provide the amount of water required by the off-taker. The SPC can receive the full payment amount unless the plant falls into a situation where it cannot produce the assured amount of water due to reasons such as disorder of the facility, delay of operational commencement, or any other reasons. In most cases, therefore, the capacity payment makes a virtually fixed income for the SPC. The amount of variable payment, on the other hand, fluctuates depending on the operational rate of the facility. This means that the SPC may not receive the expected amount of payment, if the water demand in the specified region drops, thereby pushing down the plant's operational rate.

d. Price Revision Factors

In the calculation of these revenue components, the inflation rate, and the currency devaluation rate indicated in Chapter 9.3 are taken into account in the payment formula as shown in Figure 10.1.3. Table 10.1.5 summarizes the price revision factors which should be considered in the formula shown in Figure 10.1.3.

The paragraph is omitted due to confidentiality.

The paragraph is omitted due to confidentiality.

Table 10.1.5 Price Revision Factors

The table was omitted due to confidentiality.

Source: JICA Study Team

In addition to the abovementioned factors, changes in laws and regulations (e.g., tax regulations) also may affect the payment price. Conditions for such price revision must be stipulated on the Off-take contract and BOT contract.

2) Other Revenues

The paragraph is omitted due to confidentiality.

The paragraph is omitted due to confidentiality.

10.2 Financial Analysis on the Priority Scheme

The following results were derived from the abovementioned assumptions.

10.2.1 The Results with the Assumptions Requested by the Estimated Investors

The paragraph is omitted due to confidentiality.

Provided that the average retail price as of May 2012 in Can Tho City is VND 5,834/m^3, the wholesale price has to be lower. There seems to be a considerable amount difference between the expected price by WSSC and the proposed price by the Study Team.

Table 10.2.1 shows the summaries of the financing sources and usage of SPC during construction.

Table 10.2.1 Funding Source and Investment During the Construction Period

(VND in billions, JPY in hundred million)

The table was omitted due to confidentiality.

Source: JICA Study Team

Table 10.2.2 shows the summaries of expected cash-out and cash-in of SPC during the project period after the construction period.

Table 10.2.2 Cash-out and Cash-in During O&M Period for 25 years of Operation

(VND in billions, JPY in hundred million)

The table was omitted due to confidentiality.

Source: JICA Study Team

Note:*O&M cost: 23.44 billion VND p.a,, approximately equal to JPY 88 million p.a (the price as of 2012)

* SPC administration cost: 5.3 billion VND p.a., approximately equal to JPY 20 million p.a for management cost and audit cost (the price as of 2012)

*VND amount was converted to JPY with assumed Forex of the year

Figure 10.2.1 shows the annual wholesale price per m^3 of SPC which was derived from the annual revenue dividing it by the amount of water sales per year. Although the price under the "Take or Pay" method looks higher at the beginning years of operation than the current price, its rate of price increase is lower than the expected inflation rate. This means that the price in the "Take of Pay" scheme will be comparatively cheaper in the later years of operation as compared to the current price if it increases accordingly with the inflation rate.

The figure was omitted due to confidentiality.

Source: JICA Study Team

Figure 10.2.1 Breakdown of Wholesale Price per m^3

10.2.2 Other Financial Analysis

The analysis can provide different results by applying different values for any of the following variables:

a. Amount of the construction cost
b. O&M cost
c. Target EIRR
d. Share of each fund source (senior debt/sub debt/equity)
e. Interest rate of each fund (senior debt/sub debt)
f. VND devaluation rate (against USD or JPY)
g. Inflation rate
h. Dividend rate (before/after replacement)

Since there were great differences between the tariffs estimated by the WSSC and the ones proposed by the JICA Study Team based on the conditions of prospective investors, further analysis was conducted by changing the two parameters of the abovementioned list, namely, amount of the construction cost and target EIRR.

(1) Reduction in Construction Cost

Among the assumptions shown in Sub-section 10.1.1, the JICA Study Team changed the assumption for the construction cost as shown in Table 10.2.3 to calculate the wholesale price.

Table 10.2.3 Reduction in Construction Cost as of 2012

(VND in billions, JPY in hundred million)

The table was omitted due to confidentiality.

Source: JICA Study Team

(2) Decrease in Target EIRR

Among the assumptions shown in Sub-section 10.1.1, the JICA Study Team changed the assumption for target EIRR.

The paragraph was omitted due to confidentiality.

10.2.3 Findings from Financial Analysis

The JICA Study Team has conducted a series of negotiations with the WSSC and the related departments of Can Tho City regarding the project scheme. However, the proposed wholesale price was concluded by the WSSC as inacceptable. Given the response, the JICA Study Team has no choice but to conclude that further negotiations are quite difficult to perform, because lowering the wholesale price even further is difficult under the current formation of investors.

On the other hand, the methodology to decide the retail price for clean water in Vietnam is stipulated in Joint Circular No.75/2012/TTLT-BTC-BXD-BNNPTNT (Joint Circular Guiding Principles and Method of Determination and Competence to Decide Water Consumption Price in the Urban Areas, Industrial Zones and Rural Areas) as described in Chapter 3 and the retail price shall result from the aggregate of all costs related to water treatments and water sales. Related parties in Can Tho City should consider that the reasons why the retail price in Can Tho City is low. There is the possibility that the current retail price does not need to take account the initial investment cost into the retail price, since almost all of the water is produced by the facilities assigned by Can Tho PC without any investment by the WSSC.

Although it is difficult to reach the agreement on tariff price between the related parties in Can Tho City and the JICA Study Team, the analysis considering merits and demerits in the long-term standpoint is needed, because the higher the economic growth, the demand in infrastructure increases, and financing from the private sector shall be an effective source for such investment.

10.3 Economic Benefit-Cost Analysis

In this study, an economic benefit-cost analysis was conducted by referring to the procedures provided in the Handbook for the Economic Analysis of Water Supply Projects (1999) published by the ADB (hereafter referred to as “ADB Handbook”). The purpose of economic benefit-cost analysis is to verify the economic viability of the projects by calculating the potential economic benefits, which the project could bring about to the target community. To calculate the economic benefits of a project, the costs and benefits expected “with project” are compared to those “without project”. In order to verify the economic viability of project, specific indicators, such as EIRR, ENPV, and/or B/C, are often utilized. In this study, the JICA Study Team calculated the EIRR through the following procedure.

10.3.1 Calculation of Economic Costs

(1) Financial Costs of the Proposed Project

Table 10.3.1 shows the costs of the proposed project. Unlike the financial project costs, which are the costs to the project enterprise, economic costs are supposed to reflect costs to the whole economy. Therefore, in this analysis, such costs as transfer payments (e.g., taxes, duties, and subsidies) or working capital (e.g., inventories, loan receipts, repayment flows) are excluded.

Table 10.3.1 Estimated CAPEX and OPEX

(VND in billions)

The table was omitted due to confidentiality.

Source: JICA Study Team

In order to include costs to the entire economy, following Items 1) to 3) are generally added to the project costs. However, they are assumed as not applicable for the proposed project due to the following reasons.

1) Opportunity Cost of the Land

The opportunity cost of the land used for the project needs to be accounted as an economic cost.

The paragraph was omitted due to confidentiality.

2) Opportunity Cost for Water

If the water for the project is taken from an already utilized water source and if it results in termination of the existing use, the opportunity cost of water needs to be measured and included as an economic cost.

The paragraph was omitted due to confidentiality.

3) External Effects

If the project causes considerable impacts on the external environment, such as environmental pollutions, such impacts need to be measured and included in the economic costs.

The paragraph was omitted due to confidentiality.

(2) Valuation of Economic Costs of the Project

The amount of the project costs has to be re-valued for the economic price. Economic prices are the true costs and value to the economy of goods and services after the adjustment for the effects of government intervention and distortions in the market structure. In order to eliminate the effects of government interventions and convert the above project costs (financial price) into economic price, the following conversion factors were utilized.

1) Wages for Unskilled Labors

In the labor markets, sometimes the government sets a controlled minimum wage for casual labors. However, in the economic analysis, the effect of governmental control shall be excluded. To convert financial labor price into economic price, a conversion factor called shadow wage exchange rate (SWER) is utilized.

The paragraph was omitted due to confidentiality.

2) Currency Exchange Rate

The project costs consist of traded and non-traded goods and services costs. These traded costs contain the influence of government controls, such as the effects of customs and export subsidies, etc. In order to convert them into economic price, shadow exchange rate factor (SERF) is utilized.

The paragraph was omitted due to confidentiality.

3) Costs of Electricity

The price of electricity costs needs to be adjusted to the economic price by utilizing the conversion factors for each component of production costs (e.g., fuel cost, labor cost, traded or non-traded material costs, etc.) of electricity.

The paragraph was omitted due to confidentiality.

(3) Conversion of Financial Costs of the Proposed Project into Economic Costs

Applying the abovementioned adjustments, the costs of the proposed project has been converted into economic costs as shown in Table 10.3.2[1].

Table 10.3.2 Conversion of Financial Costs into Economic Costs

(VND in billions)

The table was omitted due to confidentiality.

Source: JICA Study Team

10.3.2 Calculation of Economic Benefits

(1) Quantification and Valuation of Economic Benefits in the Water Supply Project

1) Incremental and Non-Incremental Benefits

A gross benefit from a water supply project can be estimated by identifying the incremental

[1] The Traded/Non-traded amounts of OPEX were calculated based on the percentages of shares of foreign-currency based/ VND-based portions in the total estimated maintenance costs, as well as the total estimated employee salaries plus office running costs (excl. insurance costs) for 25 years of operational period.

and non-incremental benefits of the project. The non-incremental benefit is the benefit of the new water supply system which replaced the existing sources of water supply. For example, if those users who are currently using water from wells, rivers, or vendors, the new water supply output which replaces them is considered as non-incremental benefit. On the other hand, the incremental benefit is the output of the new water supply system that meets additional or induced demand for water.

For the proposed study, the consumption quantities and the prices were calculated as shown below based on the results of the social baseline survey (See Chapter 11 and Appendix E1).

①Non-Incremental Benefit:

The paragraph was omitted due to confidentiality.

②Incremental Benefit:

The paragraph was omitted due to confidentiality.

③Total Benefit:

The paragraph was omitted due to confidentiality.

2) Benefits from the Non-Revenue Water

The NRW is caused by technical loss, such as leakage from the distribution pipes, and also non-technical loss, such as theft and dysfunctions of consumption meters. Although the NRW is excluded from the financial analysis, in economic analysis, the amount of NRW caused by non-technical loss is included as economic benefit due to the fact that such amount is actually consumed by the people unlike the amount lost for technical reasons. This is due to the concept of economic analysis, in which the economic analysis is supposed to be concerned about every participant in the society.

The paragraph was omitted due to confidentiality.

Benefit from NRW (non-technical loss):

The paragraph was omitted due to confidentiality.

10.3.3 Calculation of Economic IRR

Applying the yearly economic costs and benefits calculated above, economic IRR was calculated and the results are shown in Table 10.3.3. The ADB Handbook suggests 12% as the minimum rate required for projects to be economically viable. Since the obtained EIRR exceeds this requirement, the proposed project can be expected to bring about sufficient benefits to the target community.

Table 10.3.3 Economic IRR of the Project

The table was omitted due to confidentiality.

Source: JICA Study Team

CHAPTER 11 PRELIMINARY ENVIRONMENTAL EXAMINATIONS

11.1 Social Baseline Survey

A social baseline survey was carried out from June to July 2012 to review the current water use patterns in Can Tho City. The survey also assessed the availability of water from various sources, sanitary conditions, customer satisfaction, and willingness to pay for piped water supplied by WSSC. A total of 516 households in four urban districts were surveyed and the findings were incorporated in the financial analysis of the proposed project. The survey methodology and results are summarized below and the full report is available in Appendix E-1.

11.1.1 Survey Context and Objectives

In 2006, about 62% of urban households in Can Tho City used piped water supply, 30% used their wells, 4% used rainwater, and 2% relied on water from rivers or ponds[1]. While significant differences in coverage ratio across different urban districts remain, a more recent figure indicates that about 80% of urban residents have access to piped water[2]. The demand for piped water in Can Tho City is expected to increase due to its economic growth, population increase, and expansion of service area. The proposed project responds to this increase in demand and aims to supply water to the urban population of Can Tho City. Many urban households in Can Tho City have multiple sources of water and use them for different purposes. About one-third of the surveyed households that are connected to the WSSC system use other water source(s) to meet their daily needs. In order to assess the viability of the proposed project, it is of critical importance to understand the factors that influence water use patterns and the potential incentives which might lead to greater use of piped water. In addition, evaluating households' willingness to pay for an improvement in the water supply service to be provided by the proposed project is essential for the financial analysis of the project. In this context, a social baseline survey was carried out with the following objectives:

- Evaluate the current water use patterns (volume and types of water used for different purposes) and likely changes due to socioeconomic changes;
- Review the quality and availability of water from different sources including wells and river/canals;
- Assess the level of satisfaction among existing water sources (quantity and quality);
- Assess the willingness to pay for improved water services provided by WSSC among urban households; and

[1] The figure is based on the survey on household living standards in 2006, quoted in Can Tho University. 2011. *Water Governance Assessment*, Can Tho: Can Tho University. The total does not add up to 100% due to rounding error.
2 Carrard, N., Paddon, M., Willetts, J. and Moore, D. 2012. *Poverty Dimensions of Water and Sanitation Services and Climate Vulnerability in Can Tho City*, report prepared by the Institute for Sustainable Futures, University of Technology, Sydney.

- Review sanitary conditions and water-related health issues.

11.1.2 Methodology

1) Sample Selection

The baseline survey was carried out in 11 wards in four urban districts (Ninh Kieu, Binh Thuy, Cai Rang, and O Mon). More than 60% of the samples (516 households in total) were drawn from Ninh Kieu and Binh Thuy districts, since the proposed project aims to supply water in these districts. The wards were selected based on the population size and the existing and future service areas of WSSC, as well as the network of distribution pipes proposed under the project. Both wards at the outer edge of the service area and wards near the proposed water treatment plant were surveyed to assess the potential differences in the quality of the service. The surveyors discussed with the district office of each ward to make a list of households to be interviewed. A set of random numbers was used in selecting the households for interview from the residential registers of the administrative units (quarter) in each ward. The number of households selected from each quarter was proportionate to the quarter's population. Since the residential registers were used as the basis for sampling, only permanent residents were surveyed.

2) Survey Questionnaire

The survey was carried out from June 27 to July 11, 2012. Prior to the survey, a pilot survey was carried out on June 21 and 22, 2012 in Binh Thuy and O Mon districts, respectively, to test the validity of the questionnaire for the abovementioned objective. Upon completion of the pilot survey, the Study Team reviewed the questionnaire and adjusted the contents so that the questions were better suited to the local context and the purpose of the survey. The survey questionnaire comprises of five parts. Table 11.1.1 below provides a summary of the questionnaire. The full questionnaire is available in Appendix E-2.

Table 11.1.1 Contents of the Survey Questionnaire

Section	Theme	Information Collected
A	Basic information	● Demographic and socioeconomic information of households
B	Current water use	● Sources of water for different purposes ● Amount and cost of water used
C	Satisfaction with WSSC/ Willingness to Pay	For households connected to WSSC: ● Satisfaction with existing service (measured by various criteria such as water pressure, service reliability, taste, and smell of water) ● Willingness to pay for improved water service For households not connected to WSSC: ● Willingness to pay for WSSC service (both connection fee and monthly water tariff)
D	Sanitary condition	● Water-related diseases ● Availability and types of toilet, treatment of wastewater
E	Water-related hazard	● Impacts of flood and other water-related hazards

Source: JICA Study Team

3) Analysis and Reporting

Upon completion of the survey, the results were compiled into a database for analysis. A summary of the findings and analysis is presented in Section 11.1.3 below, and the full report is available in Appendix E-1.

11.1.3 Results of the Social Baseline Survey

1) Overview

Based on the different water use patterns and perceptions on WSSC water, the surveyed households were divided into six groups as presented in Table 11.1.2. In principle, WSSC is responsible for supplying water in four urban districts, however, the Center for Rural Water Supply and Sanitation (CERWAS) still provides water to some households in urban districts. According to the official letter[3] that stipulates the zoning arrangement, CERWAS will continue to supply water in some parts of Binh Thuy, O Mon, and Cai Rang districts up to 2020.

[3] Official Letter No. 525/UBND-XDĐT of Can Tho PC on February 15, 2012. The Department of Construction will later decide the zoning arrangement after 2020.

Table 11.1.2 Typology of Urban Households (HH)

Connected to WSSC Piped Water		**Not Connected to Piped Water**		**CERWAS**	
Use WSSC water only	Use water from mixed sources (WSSC water and well/bottled water/ rainwater, etc.)	Want to connect to WSSC if service is available	Do not want/need to connect because *- They have enough water from other sources* *- Prices are too high*	Willing to connect to WSSC water	Not willing to connect to/ interested in WSSC water
218 HH	110 HH	137 HH	20 HH	14 HH	13 HH
332 HH		**157 HH**		**27 HH**	

Source: JICA Study Team

Table 11.1.3 presents a summary of the 516 households grouped by district. The range of statistics is quite wide. Family size ranges from 1 to 17, and the average household income per month ranges from VND 400,000 to 80 million. The per capita water consumption also varies greatly, partly because some households that use river/canal water or wells do not usually measure the volume of the water they use, and therefore their self-assessment could be significantly overestimated or underestimated. Also, several households run restaurants or coffee shops within their houses[4] and thus consume significant volumes of water. In order to avoid the skewing of analysis by such outliers, both mean and median values were used in the analysis.

Table 11.1.3 Summary of Surveyed Households by District

District	No. of Households Surveyed	Average Family Size	Average Household Income per month (VND million)	Median Per Capita Water Consumption per day (L)	Mean Per Capita Water Consumption per day (L)	WSSC Service Coverage Ratio (%)
Binh Thuy	125	4.7	7.1	119	129	83.2%
Ninh Kieu	201	4.6	8.8	127	143	89.6%
O Mon	110	4.5	6.2	78	93	25.5%
Cai Rang	80	4.5	6.6	142	133	25.0%
Total/ Weighted Average	516	4.6	7.5	111	126	64.3%

Source: JICA Study Team

The above table shows interesting differences between the districts of O Mon and Cai Rang. Although the statistics of the two districts are quite similar in terms of income and WSSC service coverage ratio, the level of water consumption in Cai Rang is much higher than that in

[4] If a household runs a restaurant or coffee shop in its house, up to 4 m^3 per person is billed at VND 4,100/m^3 and water consumption beyond that amount is billed at VND 6,400/m^3 (including VAT).

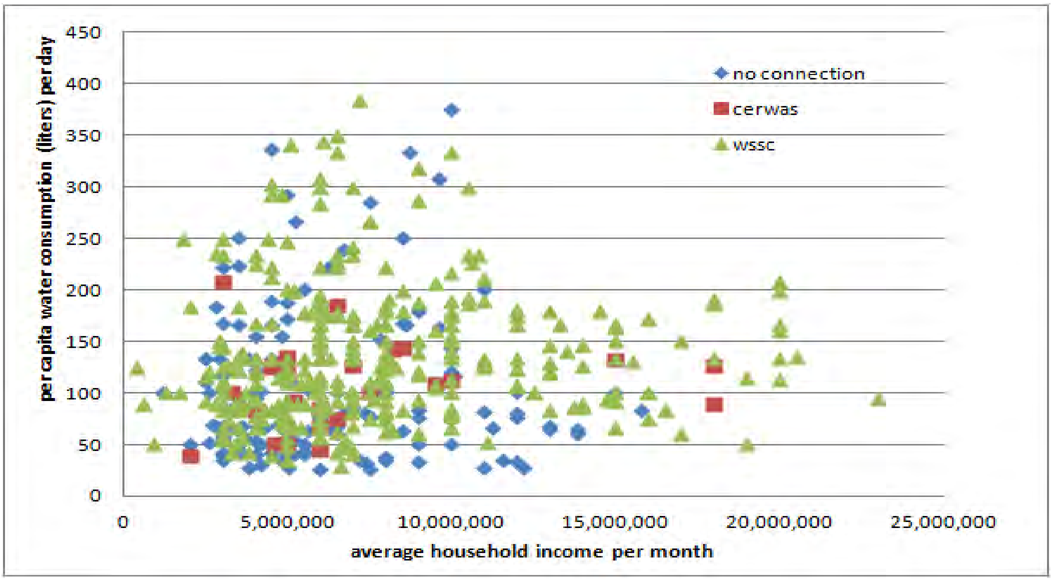
O Mon and almost equal to the level of the two more urbanized districts with higher income and service coverage ratio. Table 11.1.4 below shows the same statistics but organized by connection status. The per capita water consumption is highest among households connected to WSSC and lowest among households with no connection.

Table 11.1.4 Summary of Surveyed Households by Connection Status

Service Status	No. of Households Surveyed	Average Family Size	Average Household Income per month (VND million)	Median Per Capita Water Consumption per day (L)	Mean Per Capita Water Consumption per day (L)
WSSC	332	4.7	8.1	125	138
CERWAS	27	4.7	7.9	109	105
No Connection	157	4.3	6.1	76	102
Total/ Weighted Average	516	4.6	7.5	111	126

Source: JICA Study Team

On average, households using WSSC water earn higher income and use more water; however, this is primarily due to location rather than affordability. There is hardly any correlation between income and the level of water consumption. As shown in Figure 11.1.1 below, many households with higher income use less water compared with lower income households. Likewise, a considerable number of households without WSSC connection use more water than WSSC households with higher income. Since the price of water is very low in Can Tho, the level of income appears to have little influence on the decision of water use. The fact that only 9% of households with WSSC connection said they would use more water if their income goes up by 20% suggests that the water consumption today is not constrained by income.



Source: JICA Study Team

Figure 11.1.1 Correlation between Income and Water Consumption

2) Water Use Patterns

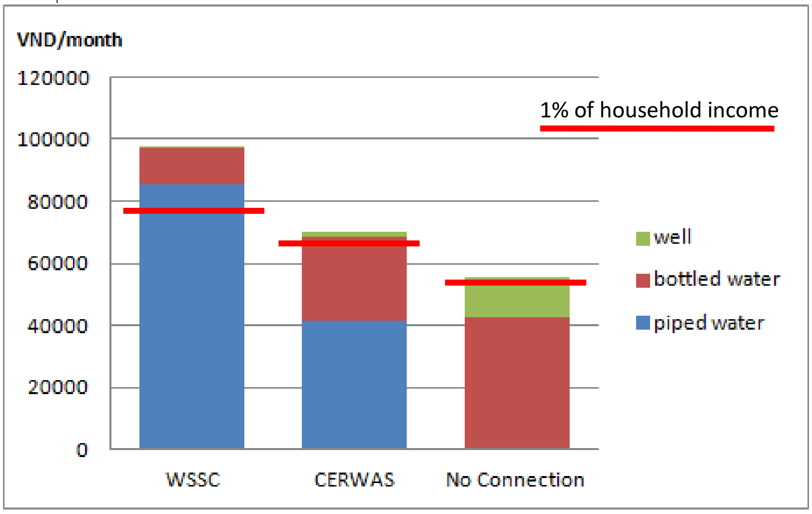
Of the 332 households connected to WSSC service, 243 households (73%) use WSSC water for drinking. Most of the households that do not use WSSC water for drinking use bottled water instead (26%). The number of households using WSSC water for cooking and washing are 328 (99%) and 309 (93), respectively. There are 221 households that use WSSC water for all their daily needs.

On the other hand, 94 households (60%) with no connection use bottled water for drinking, and 33 households (21%) use river/canal water. Among households without piped water, river/canal water is the most popular source of water for cooking and washing, followed by wells.

3) Water-related Expenditures

Figure 11.1.2 shows water-related expenditures among households with different connection status. On average, households without connection spend less on water. However, they spend considerably more on bottled water because of the lack of safe and clean water. These households also rely more on water from wells and thus spend more on the operation and maintenance of wells. Water-related expenditures among surveyed households represent only about 1% of their income for all groups, which is considerably low as compared with the benchmark indicated by the World Bank (3-5%) and the Asian Development Bank (5%)[5]. From an affordability point of view, this suggests that there is still room to increase the water tariff.

[5] Asian Development Bank. 2003. *Asian Water Suppliers - Reaching the Urban Poor,* Manila: Asian Development Bank



Source: JICA Study Team

Figure 11.1.2 Monthly Water-related Expenditures

4) Satisfaction Level of Current Users

As discussed above, 332 surveyed households are using WSSC water, but their satisfaction level varies. For households using water from the Can Tho No. 2 WTP, the satisfaction level varies greatly depending on the household location. As shown in Table 11.1.6, the satisfaction rate is highest among households using water from the Can Tho No. 1 WTP and lowest among households using water from the Can Tho No. 2 WTP. However, the low satisfaction level is heavily influenced by households in An Khanh Ward, which is located at the outer edge of Can Tho No. 2 WTP's service area. Excluding households in An Khanh Ward, the satisfaction level of households covered by the Can Tho No. 2 WTP improves to 85.9%. It further improves to 89.7% if the results from Tra An Ward, another ward located at the outer edge of the service area, are excluded.

Table 11.1.5 Satisfaction Level on WSSC's Water Service

Water Treatment Plant (capacity, m^3/day)	Satisfied	Not Satisfied	Total	Satisfaction Rate (%)
Can Tho No. 1	145	15	160	90.6%
Can Tho No. 2	57	27	84	67.9%
Can Tho No. 2 (excluding An Khanh)	*55*	*9*	*64*	*85.9%*
Hung Phu	14	6	20	70.0%
O Mon	24	4	28	85.7%
Long Hoa	29	11	40	72.5%
Total	269	63	332	81.0%

Source: JICA Study Team

From the survey, it appears that water pressure is the most significant factor affecting household satisfaction with WSSC service. Out of the 63 unsatisfied households, 43 households expressed complaints about the water pressure. In particular, 18 out of 20 households in An Khanh Ward answered that the water pressure is either “low” or “varies but usually low”. The survey results concerning other factors associated with water quality are presented in Table 11.1.5. It appears that the smell of chlorine does not have a strong influence on the household satisfaction level, although “bad” color of water may have contributed to lower satisfaction levels among households using water from O Mon and Long Hoa WTPs.

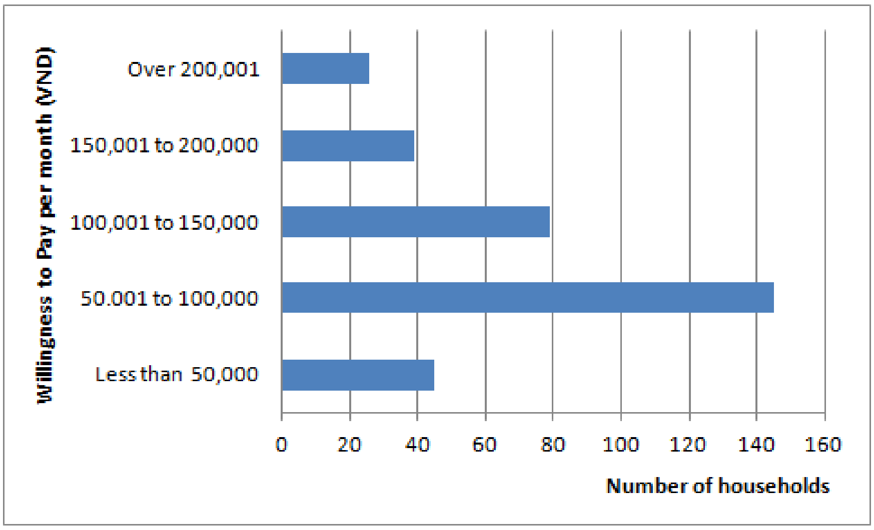
Table 11.1.6 Taste, Smell and Color of Water

Water Treatment Plant	Bad Taste		Bad Smell (Chlorine)		Bad Color	
	Never/ Rarely	Sometimes/ Usually	Never/ Rarely	Sometimes/ Usually	Never/ Rarely	Sometimes/ Usually
Can Tho No. 1	160	0	123	37	150	10
Can Tho No. 2	83	1	54	30	78	6
Hung Phu	20	0	14	6	20	0
O Mon	28	0	15	12	17	11
Long Hoa	40	0	23	17	26	14
Total	331	1	229	102	291	41

Source: JICA Study Team

5) Willingness to Pay for Improved Water Service

The survey asked 332 customers of WSSC service about their willingness to pay for an improved water service. On average, connected households pay VND 85,500/month (1.1% of median monthly income) for WSSC water service with median monthly consumption of about 16 m^3. For a better service that is more reliable, has good quality, and has stronger water pressure, they are willing to pay, on average, VND 105,000/month (1.3% of median monthly income). This is nearly VND 20,000/month more than they are paying today. Assuming that the water consumption level is consistent, this figure translates into VND 6,560/m^3 of water (VND 105,000 divided by 16 m^3), which is still below the international benchmark discussed above (see Section 11.1.3 (3)).



Source: JICA Study Team

Figure 11.1.3 Willingness to Pay for Improved Water Service (VND/month)

The survey also asked 157 households without WSSC connection their willingness to pay for the WSSC service. Out of these, 147 households answered that they are interested in getting connected to WSSC service with the average willingness to pay of VND 5,550/m^3 of water[6]. Meanwhile, the remaining ten households said they are not interested in WSSC water supply primarily because they already have satisfactory water supply, mainly through their own wells.

11.1.4 Conclusion

In Can Tho City, the price of water is quite low compared with the households' income level, and the survey found that households are willing to pay considerably more for a better water supply service. Given that water-related expenditures among surveyed households represent only about 1% of their income, the survey results suggest that there is room for increasing the water tariff. However, the survey also found that the satisfaction with WSSC service is quite low in areas with low water pressure. When considering an increase in water tariff, it is of critical importance to ensure that satisfactory water pressure is available across the entire service area in addition to providing enough volume of water.

11.2 Preliminary Environmental Impact Assessment (EIA)

A preliminary EIA has been carried out as part of the preparatory study. The preliminary EIA

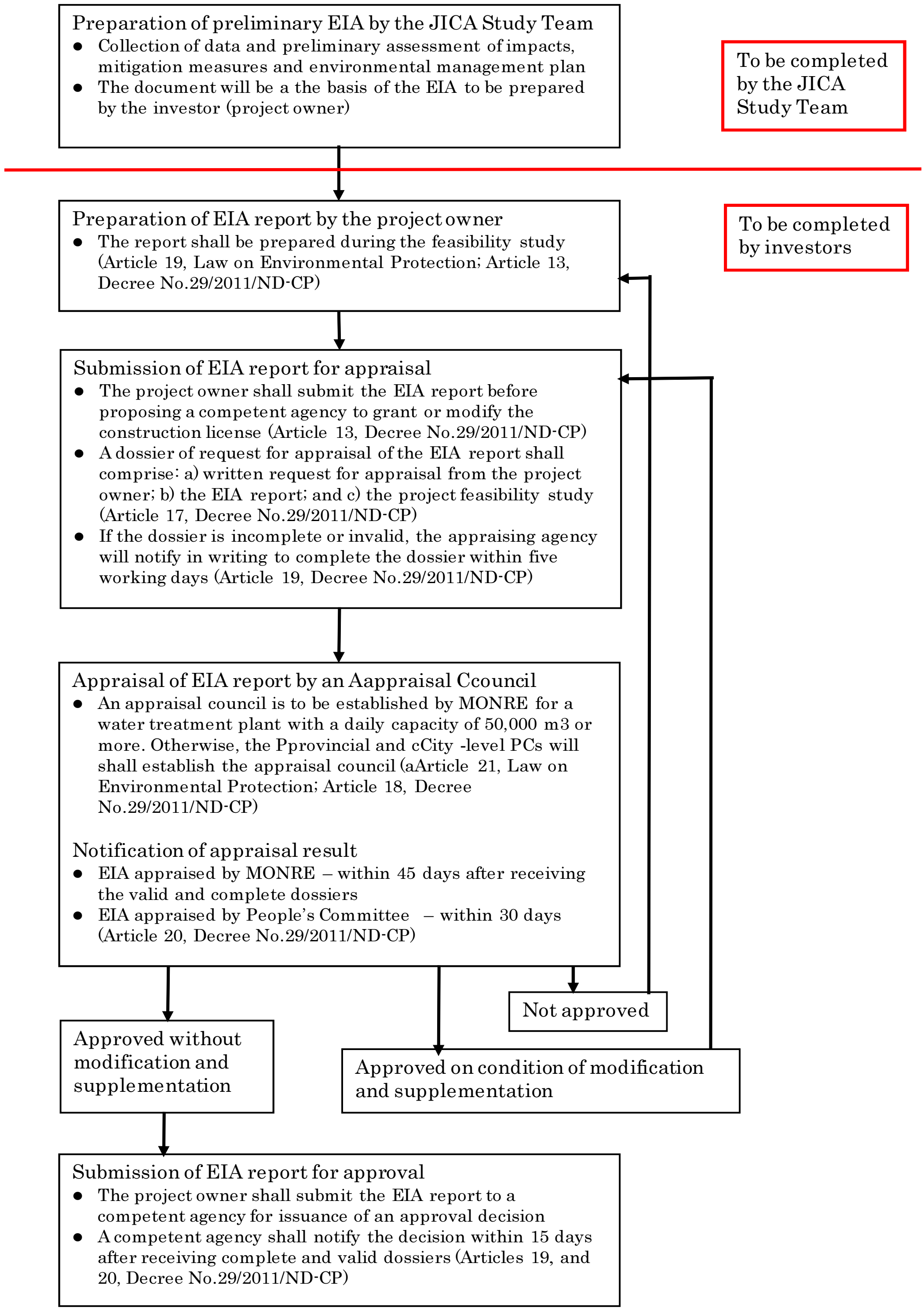
[6] The average willingness to pay is VND 50,000/month, which is less than 1% of the average monthly household income. The unit cost is estimated by dividing the willingness to pay value by the current water consumption level of these households (9 m^3). Although the figure is lower than those of existing users, this is mainly because of their low water usage, and not due to the limited affordability. Unconnected households tend to spend more on bottled water, meaning that they pay more in terms of per unit cost of water. Per unit cost of water may actually be lower if unconnected users start using WSSC water.

will facilitate the preparation of the official EIA report, which will be prepared by the project owner and submitted to DONRE for appraisal and approval at a later stage[7]. The outline of the report is available in Appendix E-3 and a summary of the results is presented below.

11.2.1 Objective of the Preliminary EIA

The Law on Environmental Protection requires owners of projects with a potential risk of causing adverse impacts to the environment to carry out an EIA (Articles 18 and 19). The detailed procedures concerning the preparation, appraisal, and approval of the EIA are prescribed in Decree No. 80/2006/ND-CP, Decree No. 29/2011/ND-CP, and Circular No. 081/2006/TT-BTNMT. The preliminary EIA carried out by the JICA Study Team will serve as the basis of the EIA to be prepared by the investors during the detailed design stage. The process of EIA appraisal and approval is presented in Figure 11.2.1 below.

[7] Article 18, 19, Law on Environmental Protection (2005)



Source: JICA Study Team

Figure 11.2.1 Procedures of EIA Appraisal and Approval

11.2.2 Vietnamese Laws and JICA Policies Concerning Environmental and Social Considerations

The amendment of the Law on Environmental Protection in Vietnam in 2005 expanded the scope and significantly strengthened the regulatory framework for environmental and social considerations. However, there are still several important differences between the regulations in Vietnam and requirements under JICA's Guidelines on Environmental and Social Considerations. The following is a brief analysis of key differences and a proposal to address the gap.

1) EIA

The contents to be included in the EIA report are specified in Article 20 of the Law on Environmental Protection. They are largely in line with the requirements specified in the JICA's Guidelines for Environmental and Social Considerations, except that Vietnamese laws and regulations do not require the analysis of alternatives. To comply with JICA's guidelines, the preliminary EIA assessed three alternatives including zero option.

2) Land Recovery, Compensation, Support, and Resettlement[8]

Recent laws, decrees and regulations on land recovery, compensation, support, and resettlement policies of the Government of Vietnam are mainly in line with those of JICA. There are, however, several important differences that require specific attention as presented in Table 11.2.1.

Table 11.2.1 Key Differences between Vietnamese and JICA's Policies

Main Issues	Vietnamese Laws and Regulations	JICA Guidelines	Project Policy (Proposed)
Persons without legal land use right	Can Tho PC will consider to support according to each case (Article 14, Decree No. 69/2009/ND-CP)	All affected persons should be compensated regardless of legal status	All affected persons should be compensated regardless of legal status
Land compensation	The amount is to be determined according to official land valuation	Full replacement cost should be provided as much as possible since the official price may not represent a full replacement cost	Full replacement cost at the market value should be provided as much as possible
Houses and other structures	Houses and other structures built after July 1, 2004 and run against the land use purpose shall not be compensated (Article 18, Decree 197/2004/ND-CP)	All affected persons will have rights to receive compensation regardless of legal conditions	All affected structures will be compensated according to replacement cost

Source: JICA Study Team

[8] Involuntary resettlement is not expected in this project. However, should it be necessary due to changes in the project design in the future, the investor will pay sufficient attention to the gaps between the Vietnamese regulations and JICA policies to ensure that the project is in compliant with JICA's Environmental and Social Guidelines.

In case there are some differences, the project will be implemented according to the Guidelines for Environmental and Social Considerations of JICA, which is in line with Decree No. 131/2006/ND-CP on the regulation on management and use of official development assistance (ODA).

11.2.3 Scoping of Environmental Impacts

In order to identify the issues that are likely to be of great importance during EIA and eliminate those that are of little concern, scoping was carried out. Table 11.2.2 presents the matrix of the potential project impacts during various stages of project development. The matrix has been prepared in consultation with stakeholders and based on literature reviews of the environmental conditions in Can Tho City.

Table 11.2.2 Scoping of Environmental Impacts

Item	Stage	Rating	Description
Social Environment			
Involuntary resettlement	-	D	The project will not trigger involuntary resettlement.
Daily life of people in surrounding areas	II	B-	Some temporary impacts are expected on the livelihood of people in the surrounding area due to dust, noise, and vibration caused by construction activities.
Local economy such as employment and livelihood, etc.	II	B+	Employment opportunity might be created due to the project implementation.
Land use	-	D	Negative impact due to land use change is not expected.
Physical community division	-	D	Physical community division is not expected due to project implementation, including access road construction.
Existing social infrastructures and services	II, III	D	The proposed water treatment plant will be constructed on vacant land, and thus impacts on existing infrastructures are not expected.
Indigenous people and ethnic minority	-	D	No ethnic minority groups live around the project site.
Misdistribution of benefit and damage	-	D	Misdistribution of benefit and damage is not expected.
Local conflict of interests	-	D	Local conflict of interests due to project implementation is not expected.
Water usage or water rights		D	There is no negative impact on water usage or water right.
Sanitation	II	B-	Some negative impacts on the local sanitary condition are expected due to the mobilization of construction workforce and/or workers' site camps, although the expected impacts will be temporary only during the construction stage.
Hazards (risks), infectious diseases	II	B-	Increase in risks of infectious diseases is probably expected among the construction workforce and/or in the workers' site camps, although such risks will be temporary only during the construction stage.
Cultural heritage	-	D	No cultural heritage is located in/near the project site.

Natural Environment			
Topography and geographical features	-	D	Construction of the water treatment plant and pipelines will not change topographical condition; therefore, negative impact to topography and geographical features is not expected.
Soil erosion	II	B-	There is a risk of soil erosion due to construction near rivers/canals.
Groundwater	-	D	The project uses surface water only and thus no impact on groundwater is expected.
Hydrological situation	II	B-	It is expected that the project component will temporarily impact hydrological conditions in and around the project area.
Flora, fauna, and Biodiversity	I, II	D	Natural vegetation is found on vacant land. However, there is no rare species listed in IUCN's Red List of Red Data Book of Vietnam.
Meteorology	-	D	It is not expected that the project will cause changes on the regional meteorological condition.
Landscape	I, II, III	D	The impact is negligible.
Pollution			
Air pollution	II	B-	Some negative impacts on air quality are expected due to operation of heavy equipment/vehicles as well as traffic jams incidental to construction works, although the expected impacts will be temporary only during the construction stage.
Water pollution	II, III	B-	There is a risk of temporary water pollution due to excavation and cutting as well as wastewater discharge from workers' camps during construction. During the operation phase, surface runoff from drying bed (in case of improper control) may cause impact on surface water.
Soil contamination	II, III	B-	Soil condition will be affected due to oil/grease leakage from operations of heavy equipment and vehicles during construction. Improper management of sludge could contaminate soil and surface/underground water.
Waste	II	B-	There is a possibility that the construction works will generate solid waste during the construction stage, including excavated soil and domestic waste from workers' camps.
Noise and vibration	II	B-	Temporary impacts of noise and vibration due to operations of heavy equipment and vehicles during construction are expected.
Ground subsidence	II, III	C	Sufficient piling is required to avoid ground subsidence.
Offensive odor	-	D	There are no project components or activities which may cause offensive odor.
Bottom sediment	II	B-	Potential impact on the bottom sediment due to improper disposal of excavated soil is expected.
Accidents	II, III	B-	There is a risk of accidents during construction works and transportation of heavy vehicles. Improper handling of chemicals may cause accidents during the operation phase.

Project Stage: I: Pre-Construction; II: Construction; III: Operation
Legend of Rating: A-: Serious impact is expected; A+: Positive effect is expected; B-: Some impact is expected; B+: Positive effect is expected to a certain extent; C-: Extent of impact is unknown. Further examination would be necessary. Impact may become clear as study progresses; D: No or negligible impact is expected.
Source: JICA Study Team

As presented above, the level of negative environmental impacts associated with the proposed project is not significant. Most of the impacts are local and temporary, which can be eliminated or mitigated by proper implementation of the project activities.

11.2.4 Main Environmental Impacts Associated with the Project and Mitigation Measures

The main environmental issues during the construction phase include noise and emissions from transport vehicles and machines, and solid waste. Sound management of sludge is a key environmental issue during the operation phase of the project. The JICA Study Team reviewed several options of sludge disposal, which will be discussed in Section 11.2.5. Other environmental impacts during the operation phase are considered to be minor, and potential environmental risks can be minimized by proper management of the water treatment plant. Anticipated environmental impacts during various stages of the project and proposed mitigation measures are summarized in Table 11.2.3 below.

Table 11.2.3 Summary of Environmental Impacts and Mitigation Measures

Activities	Impacts	Mitigation Measures
I. Pre-Construction Phase		
Site clearance	✓ Clearance of natural vegetation ✓ Dust and solid waste from land clearance ✓ Dust, noise, and exhausted gas emissions from transport vehicles	✓ Vegetation clearing shall be minimized ✓ Major works causing noise and vibration shall be carried out in such a way as to minimize impacts to neighboring population
II. Construction Phase		
- Construction of access road to the sludge drying bed area - Ground leveling and piling - Construction of WTP facilities - Construction of pipelines	✓ Temporary disturbance to neighboring households due to transport vehicles ✓ Dust, hazardous fumes, traffic congestion, noise, and vibration from vehicles and machines/equipment ✓ Domestic wastes and wastewater from workers/engineers ✓ Runoff rainwater on the construction site sweeping spilled sand, material, stone, and fuel to surface water sources ✓ Congestion during the construction of pipelines under the main road	✓ Vehicles shall be covered tightly when transporting construction materials ✓ Culvert shall be installed to collect and discharge rainwater and avoid flooding ✓ Provide protective equipment and uniform to workers, including masks, gloves, and boots ✓ Spray water to reduce dust in the construction site during the dry season
III. Operation Phase		
- Sludge and wastewater - Safety of staff	✓ Risk of overflow and direct discharge of sludge/wastewater to surface water from sludge drying bed ✓ Soil and water contamination due to improper disposal of sludge ✓ Domestic waste generated by workers ✓ Risk of accidents, injuries during operation, mismanagement of hazardous chemicals	✓ Regular monitoring of treatment process, avoidance of operation beyond the plant's capacity ✓ Proper disposal of de-watered sludge ✓ Use of proper protective equipment ✓ Install necessary firefighting equipment ✓ Separate danger zones (storage of hazardous chemical) to minimize the risk of accidents

Source: JICA Study Team

11.2.5 Sludge Disposal

Sludge generated in the water treatment process needs to be de-watered and disposed properly in compliance with Vietnamese regulations. Following Prime Minister's Decision No. 1873/QD-TTg of October 11, 2010, Can Tho City currently plans to develop new solid waste treatment and disposal facilities in 47 ha of mainly agricultural land in O Mon District. The decision stipulates that the facilities are to be developed by 2020. Land acquisition of about 20 ha has been completed as of December 2012[9], and part of the land may be used as a sludge disposal site for the BOT project once necessary facilities and infrastructures are developed. However, detailed investment and development plans are yet to be finalized at the moment.

Therefore, it is proposed that sludge is to be disposed in an existing disposal site in Cai Sao, near Hung Phu Industrial Zone. This is where sludge from Can Tho No. 1 WTP is currently disposed. The land area of the site is about 6 ha, but only small portion of the land is used at the moment (two sanitary landfills with an area of 3,000 m^2). The remaining vacant land is owned by WSSC and, if necessary, can be used without the need of additional land acquisition[10].

The Prime Minister's decision requests Can Tho PC to review existing solid waste management plans, which may lead to consolidation or closure of existing sites once the O Mon site is developed. Should the site in Cai Sao be closed during the operation period of the BOT project, supplementary EIA will need to be carried out in order to assess the environmental and social impacts associated with the development of the new site, most likely in O Mon.

11.2.6 Assessment of Alternatives

Three alternatives have been assessed during the preliminary EIA, namely: O Mon, Hung Phu, and Can Tho No. 2. The following is a brief summary of each alternative:

In the early phase of the project, O Mon was considered to be a favorable option for the project because it was located upstream of the city and thus considered less likely to be affected by saltwater intrusion. However, as discussed in Chapter 2 of the report, saltwater intrusion is not likely to pose a significant threat during the life cycle of the proposed WTP. Since O Mon is quite far from the proposed service area, the project involves the construction of nearly 20 km of pipelines. In addition, land acquisition at the O Mon site is likely to cause much greater disturbance to local livelihood as compared with the site near Can Tho No. 2

[9] 125 households have been resettled and housing structures have been cleared. However, agricultural land is still used for farming as there is no immediate plan to develop the land.
[10] The investors are required to review environmental and social issues should the expansion be necessary. Since the land is vacant with minor vegetation, likely environmental impacts will be quite limited.

WTP.

O Mon is located upstream of the Tra Noc Industrial Zone, the most vibrant industrial zone in Can Tho City and a source of surface water pollution. This is an advantage of the O Mon site, but the raw water quality in other potential sites is also good enough for the project purpose. Therefore, the advantage of being upstream does not justify greater resettlement and social disturbance. Besides, an increase in agricultural and fish farming activities further upstream will equally affect all potential sites along the Hau River, negating the advantages of the O Mon site.

A vacant land is available next to Hung Phu WTP in the Cai Rang District. However, the construction of the new plant will cause significant disturbance to local livelihood because no access road to the proposed site exists at the moment. Besides, the demand for water in the neighborhood of the area is not large (the existing Hung Phu WTP is producing below its capacity due to lack of demand). Construction of transmission pipelines will be required to bring treated water to more developed urban centers with additional socioeconomic disturbances. The JICA Study Team therefore concludes that a vacant land next to Can Tho No. 2 WTP is a more favorable location because of its proximity to a high demand area.

11.3 Conclusion

The results of the social baseline survey and preliminary EIA suggest that the proposed project will bring significant positive benefits to Can Tho City with limited adverse impacts. The proposed project will help the WSSC expand the service area and cover more urban population in the city. Since the proposed service area of the WTP overlaps with the area with low water pressure at the moment, the project will also improve the service quality for existing customers of WSSC who are willing and can afford to pay for better water supply service. The project will involve certain adverse impacts, especially during the construction phase, but these impacts are largely local and temporary, and can be minimized with proper implementation and monitoring of the project.

CHAPTER 12 OVERALL EVALUATION AND CONCLUSION

12.1 Technical Evaluation

1) According to past investigation and analytical reports on salt water intrusion, and its actual measurements carried out in this study on the downstream of the Hau River, it was clarified that salt water intrusion up to Can Tho City area will not occur in the future. Due to this reason, the construction of new water treatment and distribution facilities in and around the city area will not have any problem. In addition, the raw water quality of the Hau River as the source of the water supply system does not have any particular problem. Furthermore, the flow rate of the Hau River is 1,000 m^3/s which is maintained even during the drought period; therefore, there is no particular problem in using river water for establishing the new water supply scheme.

2) There are currently eight and five purification plants in the urban and rural areas in Can Tho City, respectively. Among these, No. 1 and No. 2 purification plants that are situated in the central part of the city have recently growing population and increasing water demand bringing about the lack of water production in these purification plants. Subsequently, these plants have no other choice than to produce about 20% more water to meet the current water deficit in the city. Therefore, it is urgently needed to rehabilitate or expand these plants, or to construct new plants in the neighboring sites. However, due to financial difficulties of WSSC, the abovementioned development programs have not been achieved yet.

3) Another reason for excessive water production of the existing No. 1 and No. 2 purification plants is the high NRW ratio. According to the quarterly data of NRW ratio in 2012, the No. 1, No. 2, and O Mon purification plants have NRW ratios of 41%, 32% and 41%, respectively. These high ratios are considered to be caused by leakages from the existing distribution networks, incomplete water charge collection from the recipient, and lack of calibration of water meters. However, sufficient investigation has not been carried out so far. Although WSSC has a plan to reduce NRW up to 20% by 2020, leakage problem may occur if the proposed scheme is started in 2017 as planned.

4) The population and water demand projections in Can Tho City are summarized in the Can Tho City Master Plan 2030. However, they are not projected for each district or for each ward. Therefore, the total population shown in the master plan was divided into categories of urban, rural, and administration, and then the water demand for the target year of 2020 is projected in this study by multiplying with the unit water demand given in the Vietnamese design standard. The division of unit water demand of industry, commercial, and institution in Can Tho City is different from the Vietnamese design standard, so that the actual water

consumption record of Can Tho City as of 2012 was derived for setting up the unit water consumption. The water demand projection carried out this time was firstly summarized in the Interim Report and has already been approved by Can Tho PC.

5) The supply capacity of the existing purification plants was compared to the 2020 water demand and the required capacity expansion was then calculated. It was identified that the total water deficit to be procured was 87,000 m^3/day in the whole Can Tho City and 79,000 m^3/day in the urban area of the city. Above all, the city center where the existing No. 1 and No. 2 purification plants are located needs the facility with the capacity of 44,200 m^3/day (daily max. capacity of 45,000 m^3/day). The location for the construction of the new facilities including intake and purification plants was set up at the neighboring vacant area of the existing No. 2 purification plant. The owner of the site is WSSC. The site for the construction of the purification plant has already been approved by the Can Tho PC.

6) The proposed purification facilities were designed with the same rapid sand filter method as the existing purification plants in the city. The major facilities of the proposed purification plant are summarized in Table 5.3.1 in Chapter 5. The intake facility was planned to be established in the neighboring canal. The pump capacity was 16.5 m^3/min (2 mains and 1 stand by) using the variable speed type. In the sedimentation basin, the tube settler was applied. For the filter, constant flow, natural equilibrium and self-washing type was selected. The wastewater from the sedimentation basin and rapid sand filter was planned to be sent to the sludge retention basin and pumped to the sludge drying bed to be located south of the proposed purification plant yard. The type of the facility will be a useful reference for the rehabilitation work of the existing No. 1 and No. 2 purification plants.

7) The transmission line from the proposed new purification plant to the existing distribution networks currently covered by No. 1 and No. 2 purification plants consists of a 4.3 km long ductile iron pipe with diameters of 700 mm, 600 mm, 500 mm and 400 mm. The connection points to the existing distribution networks were planned at the boundary between No. 1 and No. 2 distribution areas. The current water pressure heads in No. 1 and No. 2 distribution areas vary between 1-5 m and sometimes zero in some areas. Therefore, the water to be transmitted to these areas shall be able to recover the pressure up to 10 m or more. The construction of the transmission pipe is included in this BOT scheme due to the financial difficulty of WSSC and Can Tho PC.

12.2 Project Cost, Operation, and Economic and Financial Evaluation

1) For the project cost estimation, the exchange rate of Vietcom Bank as of May 2012 (JPY 1.0 = VND 266) was applied to the CAPEX and OPEX. The civil works were estimated at VND [redacted] billion (JPY [redacted] million), and the mechanical and electrical works were set at VND [redacted]

billion (JPY [redacted] million) on the basis of the Japanese manufacturer's cost estimate. Thus, the total construction cost is VND [redacted] billion (JPY [redacted] million). Furthermore, the engineering service fee and physical contingency based on the Vietnamese design criteria were added resulting to an overall project cost of VND [redacted] billion (JPY [redacted] million). The schedule of construction was planned to commence in 2014 and be completed by the end of 2016. The reduction of cost for civil works could be carried out successfully, but the electrical and mechanical cost was considerably high due to the estimation made by the Japanese manufacturer. This will be a matter for improvement from now on.

2) As for the risk analysis on the implementation of the project, it is important for both government and private sectors to share the risks appropriately and clearly. Subsequently, this will help reduce the cost of the project and also protect risk possession of the concerned parties. In order to carry out the project under the BOT scheme, the risk mitigation, risk transfer, risk sharing, countermeasure for risk actualization, application of insurances, and division of responsibility of each party are summarized in Table 8.1.1. For the BOT implementation scheme, the relationship among the organizations such as Can Tho PC, WSSC, SPC, sponsor, JICA, EPC, and O&M companies was clarified. The contract documents necessary for the implementation of the scheme were also examined.

3) In the financial analysis, the overall procurement fund, which consists of VND [redacted] billion for construction cost and VND [redacted] billion (JPY [redacted] million) for other parameters such as inflation, interest during construction, cash reserves, and performance bond, amounted to VND [redacted] billion (JPY [redacted] million) in total under the prerequisite of JICA's PSIF scheme. Based on the initial investment fund and cash dividend distribution to the three capital investors, the wholesale price of water in 2012 price level amounted to VND [redacted]/m^3. Meanwhile, Can Tho PC calculated the retail price as of 2012 at VND [redacted]/m^3, and wholesale price subsequently resulted to VND [redacted]/m^3 showing a large price difference between both parties. There are two means of mitigating this difference. One is to reduce the construction cost and the other is to reduce the level of dividend of the investors. At the same time, the awareness of the Can Tho PC and relevant authorities on water charges should be improved. Particularly, WSSC will be transformed into a joint stock company in 2014, with an independent accounting system and thus, the business regime should also be changed.

4) Economic analysis was carried out based on cost benefit assumption by setting up two cases, namely, "with project" and "without project". In general, evaluation methods such as economic internal rate of return (EIRR), economic net present value (ENPV), and benefit-cost ratio (B/C) are commonly used. However, only EIRR was applied in this study. Two types of economic benefit were considered. The first was the benefit resulting from the conversion of the existing water source into the new water source and this was considered as

"non-incremental benefit". The second was the benefit brought about by the increase of water consumption after the new scheme has started, which was called "incremental benefit". The total of the incremental and non-incremental benefit amounted to VND [redacted] billion/year. In addition to this, the benefit that can be brought by non-technical loss, out of the non-revenue water, was added. Subsequently, the EIRR resulted to [redacted]%, which is above the 12% EIRR stipulated in the ADB guidelines as the minimum level for implementation of infrastructure project.

12.3 Evaluation on Social Environmental Aspects

The baseline survey, as part of the social environmental survey in this study, was carried out from June to July 2012. The survey covered 516 households in the study area. Of these, 332 households use WSSC piped water and approximately 85% of the residents were satisfied with the water service of WSSC. However, some parts of the service area have low water pressures and the residents of such areas were not necessarily satisfied with the service. The willingness to pay for improved water service was revealed at VND [redacted]/m^3. The residents have different opinions with regard to the water charge levels made by the authorities. In the course of the study, a preliminary EIA was implemented as part of the study. In the later stages after establishing the SPC and after conclusion of the BOT contracts, an actual EIA should be carried out by the SPC implementation team.

12.4 Conclusion

This study, which targets the implementation of the project under the BOT scheme, was conducted from the beginning of May 2012 up to the end of February 2013. It included five field survey works and home works. During the period, particularly after the submission of the Interim Report in October 2012, several negotiations concerning the wholesale price between Can Tho PC with WSSC and the Study Team were carried out, but no agreement was made so far. The Study Team proposed the wholesale price of VND [redacted]/m^3 but Can Tho PC together with WSSC rejected this offer and presented VND [redacted]/m^3 as a counter proposal.

If the wholesale price issue will not be resolved and agreed between the Study Team and Can Tho PC, the approval of the central government will not be obtained for the implementation of the BOT scheme. This means that the discussion for establishing the SPC and various contract agreements in the near future will also not be concluded. Can Tho PC announced that the agreement between the two parties should be settled as soon as possible since a lot of time has been already spent for the negotiation. The Study Team should therefore provide an answer on how to proceed with this project.

However, the Study Team could not find a suitable solution to solve the wholesale price issue, so that it is necessary to terminate the project in the near future. In this regard, it is indispensable for the Study Team to officially propose the termination. Likewise, Can Tho PC should also state and provide their comments for the termination to the Study Team and JICA as well.