APPENDIX B

CASE STUDY FOR URBAN WATER SUPPLY PROJECT

CONTENTS

Tables

Annexes

B.1 INTRODUCTION

B.1.1 General

1. This Appendix provides the reader with an example of several steps which are conducted in the process of economic benefit-cost analysis. The concepts which are used have been discussed in (previous) chapters of the Handbook. The example is simplified. It is based on case studies conducted in Viet Nam. The focus is on one consumer-group: households using house connections. In this example, the following will be discussed:

(i) analysis of present water consumption;
(ii) forecast of water demand, with- and without-project;
(iii) financial benefit-cost analysis;
(iv) economic benefit-cost analysis;
(v) sensitivity analysis of the ENPV;
(vi) sustainability;
(vii) distribution analysis and poverty impact reduction.

2. Preceding the case study, a least-cost analysis, including and based on water demand forecasting, has identified the preferable option. The least-cost analysis itself is not presented. The text and tables will refer to the case studies as “the Project”. These tables will show the benefits and costs for selected years. Tables presenting each year of the project life are given in Annexes to Appendix B.

B.1.2 Description of the Project

3. The population of the town, living within the service area in 1996, is estimated at 100,000. The population is increasing at 3 percent per year due to natural growth and immigration from rural areas.

4. The project’s objective is to increase piped water supply to households within the service area from its present coverage of 45 percent to 70 percent by year 2000, and 80 percent by 2005. Household surveys have indicated that this is a realistic goal (85 percent of the population stated a clear preference for piped water services).

5. The data above form the basis of the demand forecast as shown in the annexes. The forecast is used to further formulate and design the project. For phase 1 investments, the supply capacity is designed to meet the year 2005 project demand forecast of 2.6 Mm^3 per year. To meet increased demand beyond 2006, a phase 2 project is required. Phase 2 is not included in the analysis. The utility will supply water of good quality at adequate pressure 24 hours per day. It is expected that the first new households will benefit from the project in year 1997. The lifetime of phase 1 investments is 30 years.

B.1.3 With- and Without-Project Cases

6. At present, 45,000 persons are supplied with piped water services through 7,500 connections. The quality of water obtained from the existing supply system is adequate, but the quantity of water is mostly insufficient (i.e., water is supplied less than 24 hours a day). The proposed project includes a reinforcement and extension of the existing supply system. However, no major rehabilitation of the system is foreseen in the project. It has therefore been considered that rehabilitation, if required, will take place outside of the project. The water supply company can maintain its existing level of service in the without-project situation. Consequently, the without-project piped water supply is assumed to remain constant in the without-project situation.

B.1.4 Prices and Currency

7. Throughout the analysis, the domestic price numeraire will be used. All prices are expressed in constant values of the base year, 1996. The currency is Viet Nam Dong, VND. The exchange rate used is $1 = VND11,000.

B.1.5 Project Lifetime

8. The project lifetime is 30 years (1996-2026), including an implementation period of four years. Year 2026 is the last year when benefits and costs due to the project are expected to occur. The project is designed to meet demand through 2005. In the tables in this Appendix, the main project variables remain constant in the period 2006-2026.

B.2 ANALYSIS OF VOLUME and COST OF PRESENT DEMAND

9. As part of the study, a household survey of 200 nonconnected households and 100 connected households has been conducted.

B.2.1 Present Water Consumption

10. Nonconnected households. Detailed data on the present consumption of nonconnected households are presented in Annex B.1. The consumption per nonconnected household per month was estimated on the basis of daily quantities of water collected from a specific source. In a second step, this estimate was corrected for the number of days and months that the source is not used. The estimated demand is 13.5 m^3 per household per month. The average household size is 5.7 persons. The present per capita consumption is approximately 78 liters per day.

11. Connected households. The average piped water consumption for a connected household is currently 85 lcd, which is not sufficient to satisfy demand. The collected data show that an additional 15 lcd is collected from secondary sources, mainly from open wells.

B.2.2 Present Supply Cost of Water

12. Nonconnected households. Nonconnected households obtain water from alternative sources. According to the survey, water is obtained mainly from neighbors, wells with electric pumps, open wells and vendors, as shown in column H of Annex B.1. The costs involved relate to collecting time, cash expenditures for water and investments.

13. The average collecting time per household is 36 minutes per day and the average consumption per household is 445 liters per day (5.7 x 7.8). It thus takes a household about one hour and 20 minutes to collect 1 m³ of water (36/0.445 = 81 minutes). The value of time is estimated on the basis of the observed wage rate for unskilled labor in construction work of VND3,000 per hour in the project area.

14. The cash expenditures for water obtained from neighbors and vendors constitute a major part of the supply cost. In the project area, some households sell (from piped and non-piped sources) water to their neighbors at prices close to the prices of vendors (VND10,000 - 13,000 per m³).

15. The investment costs in alternative sources range from VND250,000 for tankers to VND1.3 million for wells with electric pumps. These have been converted to a per m³ equivalent by using a capital recovery factor, with a 12 percent interest and an assumed lifetime of 15 years.

16. This approach has also been applied to the cost of storage facilities (on average VND450,000 per household). The average cost of storage facilities comes therewith on approximately VND500 per m³.

17. Table B.1 depicts the supply cost of water from the four most important alternative sources as they are used by nonconnected households. Also shown is the proportion of water obtained from that source as a percentage of total of water consumed. The data are rounded off, and are based on the detailed data in Annex B.1.

Table B.1 Financial and Economic Cost of Water from Various Sources

	% of water consumed	financial demand price (VND/m³) source	storage	total	cost break down (%) traded	Non-traded Labor	Equipment	economic supply cost [a/] (VND/m³)
CF [b/]					1.11	0.65	1.00	
Neighbor	10%	18,100	500	18,600	20%	40%	40%	16,409
Electric well	10%	3,300	500	3,800	30%	60%	10%	3,129
Open well	70%	3,200	500	3,700	10%	80%	10%	2,705
Vendor	10%	18,500	500	19,000	20%	50%	30%	16,097
Total/Ave	100%	6,230	500	6,730	20%	49%	31%	5,457

[a/] using domestic price numeraire

[b/] Conversion factor for traded items is the SERF of 1.11, for (unskilled) labor 0.65 and for other non-traded 1.00

18. The financial demand price of water obtained from neighbors and vendors is approximately VND19,000 per m³; and of water obtained from open wells or from electric wells, VND3,700 - 3,800 per m³. The (weighted) average financial demand price is VND6,730 per m³.

19. This financial price has been apportioned into a traded component, a (unskilled) labor component and a nontraded equipment component. To estimate the economic supply cost of water, the traded component has been shadow-priced with the SERF of 1.11, the unskilled labor component with the SWRF of 0.65 and the nontraded component with a conversion factor of 1.00. The average economic supply cost of water obtained from alternative sources is VND5,457 per m³.

20. Connected households. Connected households use approximately 15 lcd of water from alternative sources, mainly from open wells. The survey indicated that the costs involved are comparable to the cost for nonconnected households. The financial demand price of water from alternative sources has therefore been taken at VND3,700 per m³, and the economic supply cost at VND2,705 per m³.

B.3 WATER DEMAND FORECAST

21. The population and demand forecast for the project in years 1996-2005 are given in Tables B.2 to B.5. The project supply capacity of 3.6 Mm³ is designed to meet the year

2005 demand, the time horizon of the project. The lifetime of the project is 30 years. Constant benefits and costs will occur from 2006 until year 2026. It is necessary to look at the demand for water with the project and without the project because economic benefits of the project occur as a result of a change in cost of water and the induced change in demand. The focus is consequently on incremental and nonincremental water, used by existing and new consumers.

B.3.1 Population and Coverage

22. A summary of the data is presented in Table B.2 (lines 1-5). As shown in this Table, the population in the service area (100,000 in 1996) is expected to grow at an annual rate of 3 percent, slightly above the national average, due to natural growth and immigration from rural areas. The population increases to 130,000 by the year 2005. The project aims at a gradual increase in coverage, from the present 45 percent of the population to 70 percent in 2000 and 80 percent in 2005. The population served with the project increases by almost 60,000 consumers, from 45,000 consumers in 1996 to 104,000 persons by the year 2005.

Table B.2 Population and Coverage

		Unit	1996	1997	2000	2005	2006 2026
1	Population and coverage						
2	Population growth	%	3.0%	3.0%	3.0%	3.0%	
3	Population in service area	person	100,000	103,000	112,551	130,478	130,478
4	Coverage (present/target)	%	45%	51%	70%	80%	80%
5	Population served with project	person	45,000	52,530	78,786	104,382	104,382

B.3.2 Demand Without-Project

B.3.2.1 Existing Consumers

23. Relevant data are presented in Table B.3, lines 6-17. The water supply system is maintained and operated at a level that is required to continue providing the existing level of services to 45,000 consumers through 7,500 existing connections. Without the project, no further service extension (in terms of volume, connections, quality) will occur.

24. The total per capita demand of water of 100 lcd in 1996 grows by 0.5 percent annually to 105 lcd in 2005. Since the existing water supply system operates at its maximum capacity, this demand will meet only 85 lcd of piped water (i.e., the present level of piped water supplied). The remaining 15 to 20 lcd would have to be obtained from other sources. The total piped water consumption is 1.4 Mm^3 per year. Water obtained from other sources would increase from 246,000 m^3 in 1996 to 322,000 m^3 by 2005.

B.3.2.2 Consumers of Water from other Sources

25. Relevant data are presented in Table B.3, lines 19-23. In the without-project water demand projection, the focus is on the without-project demand for water obtained from other (than piped water) sources for the portion of the population which will be connected *with and as a result of the project*. It is the consumption of water from other sources that will be displaced as a result of the project. The number of new consumers is obtained by deducting the existing population served (line 10) from the target population to be served (line 5). Ultimately, 59,000 additional consumers will benefit from the project. Their existing 1996 water demand from other sources of 78 lcd is assumed to grow at 0.5 percent annually to reach 82 lcd by 2005 and to total 1.8 Mm^3 by 2005.

Table B.3 Demand for water, without-project

		unit	1996	1997	2000	2005	2006 2026
6	WITHOUT-PROJECT						
7	Existing consumers						
8	Number of connections	no	7,500	7,500	7,500	7,500	7,500
9	Person per connection	person	6.00	6.00	6.00	6.00	6.00
10	Persons served	person	45,000	45,000	45,000	45,000	45,000
11	Increase in per capita demand	%		0.5%	0.5%	0.5%	
12	Total per capita demand	lcd	100	101	102	105	105
13	Per capita piped water consumption	lcd	85	85	85	85	85
14	Per capita water consumption other source	lcd	15	16	17	20	20
15	Total piped water consumption	'000 m³	1,396	1,396	1,396	1,396	1,396
16	Total water consumption other source	'000 m³	246	255	279	322	322
17	Total water demand	'000 m³	1,643	1,651	1,676	1,718	1,718
18							
19	Consumers of water from other sources						
20	Number of persons	person	0	7,530	33,786	59,382	59,382
21	Increase in per capita demand	%		0.5%	0.5%	0.5%	
22	Per capita demand other sources	lcd	78	78	80	82	82
23	Total water demand other sources	'000 m³	0	215	981	1,768	1,768

B.3.3 Demand with the Project

Data on demand are presented in Table B.4.

B.3.3.1 Per Capita Consumption

26. The per capita demand forecast, which is assumed equal for existing and new consumers, is built around the assumptions of a price elasticity of -0.35 (i.e., based on survey data) and an income elasticity of 0.50 (literature) [lines 25-34]. The forecast considers that:

(i) financial analysis at the enterprise level shows that the tariff should be increased to meet the financial targets set in the loan covenant of the project. An annual

increase of 2 percent (in real terms) is proposed. As a result, the existing tariff of VND2,800 per m³ will increase to VND3,346 per m³ by the year 2005. This price increase is, *ceteris paribus*, expected to cause a 0.7 percent annual demand reduction (0.02 x -0.35); and

(ii) macro-economic forecasts for the country estimate a 2.5 percent real per capita income increase. This income increase is, *ceteris paribus*, expected to cause a 1.25 percent annual demand increase (0.025 x 0.50).

27. The net effect is a 0.55 percent annual increase in per capita demand. The per capita piped water demand increases moderately from 100 lcd in 1996 to 105 lcd by the year 2005. After 2005, no further increase in the per capita demand has been assumed.

B.3.3.2 Existing consumers

28. Since the financial demand price of water from other sources including open wells is above the price of piped water, and since supplies of piped water are no longer constrained, the project is expected to replace all water previously obtained from other sources [lines 36-41]. The per capita piped water demand increases from 85 lcd in 1996 to 101 lcd in 1997, as a result of replacement and as a result of price and income effects. The total piped water demand will reach 1.7 Mm³ per year by 2005.

B.3.3.3 New Consumers

29. The number of persons to be served is a result of the set targets. The number of new connections is determined by the average household size of 5.70 persons [lines 43-48]. The project water is expected to fully displace water obtained from alternative sources. The new consumers will develop a similar consumption pattern as that of old consumers. The total piped water demand will reach 2.3 Mm³ per year by 2005.

B.3.3.4 Total Demand and Required Capacity

30. The total piped water demand with the project will reach 4.0 Mm³ annually by the year 2005 [lines 50-55]. Unaccounted for water with the project is expected to decrease from its present 35 percent to 25 percent by the year 2000 due to the purchase of leakage detection equipment and monitoring systems. As a result, a part of the additional demand can be met by the existing supply capacity. The total piped water production will reach 5.3 Mm³ by the year 2005 (4.0/(1-0.25). The total required supply capacity is calculated on basis of a peak factor of 1.15 and increases from the present 2.5 Mm³ per year to 6.1 Mm³ (5.3 x 1.15) per year by the year 2005.

B.3.3.5 Project Water Supply

31. This section indicates the additional volumes of water sold and produced as a result of the project [lines 56-60]. The volume of project water sold is determined on a with- and without-project basis. For example, without the project, 1.4 Mm^3 is sold in the year 2005 (line 15) while with the project, 4.0 Mm^3 (line 51). Hence, the Project has increased the volume of water sold by 2.6 Mm^3.

32. The volume of project water produced is determined by the increase in water production as compared to the base year 1996 (line 53). In 2005, it reaches 3.2 Mm^3 per year (i.e., 5.3 Mm^3 - 2.1 Mm^3). The project should add an additional supply capacity of 3.6 Mm^3 per year for the 2005 horizon (i.e., 6.1 Mm^3 - 2.5 Mm^3, lines 55 and 59).

Table B.4 Demand for Water, with the Project

		unit	1996	1997	2000	2005	2006 2026
24	WITH-PROJECT						
25	Per capita consumption						
26	Tariff increase	%		2.00%	2.00%	2.00%	
27	Tariff	VND/m³	2,800	2,856	3,031	3,346	3,346
28	Price elasticity			-0.35	-0.35	-0.35	-0.35
29	Price effect on demand	%		-0.70%	-0.70%	-0.70%	0.00%
30	Income elasticity			0.50	0.50	0.50	0.50
31	Per capita income increase	%		2.50%	2.50%	2.50%	
32	Income effect on demand	%		1.25%	1.25%	1.25%	0.00%
33	Total effect	%		0.55%	0.55%	0.55%	0.00%
34	Per capita piped water demand	lcd	100	101	102	105	105
35							
36	Existing consumers						
37	Number of connections	no	7,500	7,500	7,500	7,500	7,500
38	Person per connection	person	6.00	6.00	6.00	6.00	6.00
39	Persons served	person	45,000	45,000	45,000	45,000	45,000
40	Per capita piped water demand	lcd	85	101	102	105	105
41	Total piped water demand	'000 m³	1,396	1,652	1,679	1,726	1,726
42							
43	New consumers						
44	Persons to be served	person	0	7,530	33,786	59,382	59,382
45	Person per connection	person	na	5.70	5.70	5.70	5.70
46	Number of connections	no	na	1,321	5,927	10,418	10,418
47	Per capita piped water demand	lcd	na	101	102	105	105
48	Total piped water demand	'000 m³	na	276	1,261	2,277	2,277
49							
50	Total						
51	Total piped water demand	'000 m³	1,396	1,928	2,939	4,003	4,003
52	Unaccounted for water	%	35.0%	32.5%	25.0%	25.0%	25.0%
53	Total piped water production	'000 m³	2,148	2,856	3,919	5,337	5,337
54	Peak factor		1.15	1.15	1.15	1.15	1.15
55	Required capacity	'000 m³	2,470	3,285	4,507	6,138	6,138
56	PROJECT WATER SUPPLY						
57	Project water sold	'000 m³	0	532	1,543	2,607	2,607
58	Project water produced	'000 m³	0	708	1,771	3,189	3,189
59	Existing supply capacity	'000 m³	2,500	2,500	2,500	2,500	2,500
60	Required proj. supply capacity	'000 m³	0	785	2,007	3,638	3,638

B.3.3.6 Project Water Consumption

33. The data are presented in Table B.5, lines 61-70. This section separates the total project water demand into incremental and nonincremental demand. The distinction is important when valuing water in economic terms.

34. The demand forecast has assumed that all water from other than piped sources will be replaced; this is the non-incremental water and is shown in lines 16 and 23. The remainder of the project water delivered is incremental water. which is the difference between the with- and without-project consumption (i.e., line 41-line 17, line 48-line 23). The Table shows that the most of the project water sold (i.e., 2005: 0.3+2.3=2.6 Mm³) displaces water from other sources (2005: 0.3+1.8=2.1 Mm³). The remainder adds to the total water consumption (2005: 0.5 Mm³).

Table B.5 Project Water Consumption

		unit	1996	1997	2000	2005	2006 2006
61	PROJECT WATER CONSUMPTION						
62	Existing consumers						
63	Nonincremental water	'000 m³		255	279	322	322
64	Incremental water	'000 m³		1	3	8	8
65	Project water sold	'000 m³		255	283	329	329
66							
67	New consumers						
68	Nonincremental water	'000 m³		215	981	1,768	1,768
69	Incremental water	'000 m³		61	279	509	509
70	Project water sold	'000 m³		276	1,261	2,277	2,277

B.4 FINANCIAL BENEFIT-COST ANALYSIS

B.4.1 Project Revenues

35. The data are presented in Table B.6, lines 71-79. The financial revenues of the project are made up of revenues on project water sold and connection fees. The connection fee is VND0.5 m per connection. All other data needed to calculate the financial revenues (i.e. the project water sold, tariffs and connections) stem from previous sections (lines 57; 27 and 46). From year 2006 and onwards, no new connections due to the project have been projected and

hence, no additional connection fees are received. The financial revenues will remain constant at VND8.7 billion per annum in years 2006 to 2026.

Table B.6 Project Financial Revenues

		unit	1996	1997	2000	2005	2006 2026
71	Project water sold						
72	Project water sold	'000 m³	0	532	1,543	2,607	2,607
73	Tariff	VND/m³	2,800	2,856	3,031	3,346	3,346
74	Project revenues from sales	VND m.	0	1,519	4,678	8,722	8,722
75	Connection fees						
76	New connections per year	no.	0	1,321	1,745	978	0
77	Connection fee	VND m.	0.50	0.50	0.50	0.50	0.50
78	Project revenues from connections	VND m.	0	661	872	489	0
79	Total Project Revenues	VND m.	0	2,179	5,550	9,211	8,722

B.4.2 Project Costs

The data on project costs are presented in Table B.8.

B.4.2.1 Investments

36. For selecting the project, a least-cost analysis on the basis of preliminary economic cost estimates was carried out among the different project alternatives [lines 80-92]. The economic analysis given in this Appendix is for the project selected through the least-cost analysis. The cost of the chosen least-cost alternative includes the development of a new source, water treatment plant, ground and elevated storage, pump station, distribution system, sanitation and drainage, consulting services, investigations and institutional support. Including physical contingencies calculated at 8 percent of the project cost subtotal, the total project cost is estimated to be VND64.5 billion. The investment costs are scheduled for disbursement during 1996-1999. Details are given in Table B.7.

Table B.7 Project Investment and Disbursement Profile

	Total	Disbursement in project years (%)			
	VND m.	1996	1997	1998	1999
Source development	18,000	40%	40%	20%	0%
Water treatment	2,475	40%	30%	30%	0%
Ground storage	360	20%	50%	30%	0%
Elevated storage	1,620	20%	50%	30%	0%
Pump station	675	40%	50%	10%	0%
Distribution system	18,000	20%	60%	10%	10%
Sanitation and drainage	3,150	30%	30%	20%	20%
Consulting services	9,900	50%	40%	10%	0%
Investigations	180	50%	40%	10%	0%
Institutional support	5,400	20%	30%	30%	20%
Subtotal	59,760				
Physical contingencies @ 8%	4,781				
Total investment	64,541				

B.4.2.2 Operation and Maintenance

37. The operation and maintenance costs, expressed as a percentage of the total project investment, comprise of: labor (0.5percent); electricity (1.0percent); chemicals (0.7percent); and other O&M (0.9percent) [lines 93-98]. An adjustment for a real increase of the price of labor has been made. The wages have been assumed to increase by the percentage real growth in per capita income of 2.5 percent per annum. The cost of operating and maintenance are expected to reach some VND2.1 billion per annum in project year 2005.

B.4.2.3 Raw Water Tax

38. The proposed project diverts water from a water reservoir which is located just outside the town [lines 89-93]. The reservoir is also used for a medium sized irrigation scheme of 3,000 hectares. The local irrigation authority, which is responsible for the management and operation of the reservoir, has imposed a raw water tax. The water supply utility pays VND200 per m^3 of water diverted from the reservoir. The additional raw water taxes due to the project are applied to all water produced by the project (line 100 = line 58). The utility will pay an additional VND638 million per year to the authority once the Project reaches its full capacity.

Table B.8 Project Costs							
		Unit	1996	1997	1998	1999	2006 2026
80	Investments						
81	Source development	VND m.	7,200	7,200	3,600	0	0
82	Water treatment	VND m.	990	743	743	0	0
83	Ground storage	VND m.	72	180	108	0	0
84	Elevated storage	VND m.	324	810	486	0	0
85	Pump station	VND m.	270	338	68	0	0
86	Distribution system	VND m.	3,600	10,800	1,800	1,800	0
87	Sanitation and drainage	VND m.	945	945	630	630	0
88	Consulting services	VND m.	4,950	3,960	990	0	0
89	Investigations	VND m.	90	72	18	0	0
90	Institutional support	VND m.	1,080	1,620	1,620	1,080	0
91	Physical contingencies @ 8%	VND m.	1,562	2,133	805	281	0
92	Total investment	VND m.	21,083	28,800	10,867	3,791	0
93	Operation and maintenance						
94	Labor	VND m.	0	256	319	348	403
95	Electricity	VND m.	0	499	608	645	645
96	Chemicals	VND m.	0	349	425	452	452
97	Other O&M	VND m.	0	449	547	581	581
98	Total O&M	VND m.	0	1,553	1,899	2,026	2,081
99	Raw water tax						
100	Project water produced	'000 m^3	0	708	1,040	1,375	3,189
101	Raw water tax/m^3	VND/m^3	200	200	200	200	200
102	Project raw water tax	VND m.	0	142	208	275	638
103	Total project costs	VND m.	21,083	30,495	12,974	6,091	2,719

B.4.3 FNPV and FIRR

39. The data for calculating FNPV and FIRR are presented in Table B.9 lines 104-108. The project costs are deducted from the project revenues on an annual basis to estimate the net cash flow of the project (line 108). The FIRR of 6.26 percent is just below the (assumed) WACC of 7 percent. The FNPV at 7 percent is negative VND4.8 billion. (The cash flow for all project years 1996-2026 is appended as Annex B.2.)

Table B.9 FNPV and FIRR

		Unit	PV @ 7%	1996	1997	2000	2005	2006 2026
104	Revenues project water sold	VND m.	77,387	0	1,519	4,678	8,722	8,722
105	Revenues connection fees	VND m.	3,633	0	661	872	489	0
106	Total project revenues	VND m.	81,020	0	2,179	5,550	9,211	8,722
107	Total project costs	VND m.	85,773	21,083	30,495	2,389	2,719	2,719
108	Net cash flow	VND m.	-4,753	-21,083	-28,315	3,161	6,492	6,004
109								
110	FIRR		6.26%					
111	FNPV @ 7%	VNDm.	-4,753					

B.5 ECONOMIC BENEFIT-COST ANALYSIS

B.5.1 Economic Benefits

40. The demand and supply prices of water obtained from alternative sources differ significantly for existing and for new consumers as shown in Table B.10. Therefore, incremental and nonincremental project water has been valued separately for new and existing consumers.

B.5.1.1 Existing Consumers

41. The value of nonincremental water is based on the economic supply cost of water (i.e., resource savings) displaced by the project [lines 112-115]. In the case of existing consumers, this is the cost of water obtained from open wells, estimated at VND2,705 per m³ (1996). The cost involves a high labor component (80 percent), which is mainly for collecting water. On the basis of a 2.5 percent annually per capita real income growth, the economic supply cost has been increased by 2 percent (80% x 2.5%) each year, from VND2,705 per m³ in 1996 to VND3,233 in 2005. The value of nonincremental water increases to VND10 billion by the year 2005 and remains constant in years 2006-2026.

42. The value of incremental water is based on the average willingness to pay as a proxy for the demand price of water for the project [lines 117-121]. The demand price of water without the project is the financial demand price of water from open wells, VND3,700 per m³ in 1996 (refer Table 1). The average demand price of water with the project is equal to the tariff, VND2,800 per m³ in 1996. Both prices are increasing at 2 percent annually. The total value of incremental water reaches VND30 million by the year 2005 and remains constant in the years 2006-2026.

B.5.1.2 New consumers

43. In the case of new consumers, the weighted average of the economic supply cost of water from alternative sources of VND5,457 per m³ in 1996 (Table 1) is used to value nonincremental water [lines 122-125]. This supply cost is based on the cost of water obtained from wells, vendors and neighbors. It comprises approximately 50 percent labor. On the basis of a 2.5 percent annual per capita income growth, this cost has been increased by 1.25 percent annually (50% x 2.5%). By the year 2005, the total value of nonincremental water amounts to VND10.9 billion.

44. The average demand price with and without the project determines the value of incremental project water [lines 127-131]. The financial demand price of water without the project is VND6,730 per m³ (Table 1) and with the project, it is equal to the tariff of VND2,800 per m³ in 1996. Again, the tariff increases by 2 percent annually, and the demand price of water without the project by 1.25 percent. The value of incremental water reaches VND2.8 billion by the year 2005.

B.5.1.3 Total Value of Project Water

45. The total value of incremental and nonincremental water to old and new consumers make up the total gross economic benefit of the project as summarized in Table B.10 [lines 132-135]. The largest portion of project water will displace water previously obtained from other sources. The value of nonincremental water reaches VND11.8 billion by 2005; the value of incremental water, VND2.8 billion; and the total value of project water, VND 14.6 billion.

Table B.10 Gross Economic Benefits							
		unit	1996	1997	2000	2005	2006 2026
112	Existing consumers						
113	Nonincremental water	'000 m³	0	255	279	322	322
114	Economic supply price n.i. water	VND/m³	2,705	2,759	2,928	3,233	3,233
115	Value of nonincremental water	VND m.	0	702	818	1,040	1,040
116							
117	Incremental water	'000 m³	0	1	3	8	8
118	Demand price w/o project	VND/m³	3,700	3,774	4,005	4,422	4,422
119	Demand price with project (tariff)	VND/m³	2,800	2,856	3,031	3,346	3,346
120	Average demand price	'000 m³	3,250	3,315	3,518	3,884	3,884
121	Value of incremental water	VND m.	0	3	12	30	30
122	New consumers						
123	Nonincremental water	'000 m³	0	215	981	1,768	1,768
124	Economic supply price n.i. water	VND/m³	5,457	5,522	5,724	6,075	6,075
125	Value of nonincremental water	VND m.	0	1,190	5,616	10,743	10,743
126							
127	Incremental water	'000 m³	0	61	279	509	509
128	Demand price w/o project	VND/m³	6,730	6,811	7,059	7,493	7,493
129	Demand price with project (tariff)	VND/m³	2,800	2,856	3,031	3,346	3,346
130	Average demand price	VND/m³	4,765	4,833	5,045	5,419	5,419
131	Value of incremental water	VND m.	0	294	1,409	2,758	2,758
132	Total value project water						
133	Value nonincremental water	VND m.	0	1,892	6,435	11,783	11,783
134	Value incremental water	VND m.	0	297	1,421	2,788	2,788
135	Total value project water (gross benefit)	VND m.	0	2,189	7,855	14,571	14,571

B.5.2 Calculation of Economic Project Costs

B.5.2.1 Investment

46. The investment cost of the project has been apportioned into: (i) traded; (ii) unskilled labor (non-traded); and (iii) other non-traded components as summarized in Table B.11 [lines 136-148].

Table B.11 Conversion of (Financial) Investment Cost ***(1996 VND m.)***

	Financial cost	breakdown			Economic a/
		% Trad	Unsk. Lab	Other	
Conversion factor		1.11	0.65	1.00	
Source development	18,000	70%	15%	15%	18,455
Water treatment	2,475	60%	20%	20%	2,467
Ground storage	360	40%	20%	40%	351
Elevated storage	1,620	40%	20%	40%	1,579
Pump station	675	70%	20%	10%	680
Distribution system	18,000	40%	20%	40%	17,540
Sanitation and drainage	3,150	50%	20%	30%	3,105
Consulting services	9,900	70%	0%	30%	10,670
Investigations	180	25%	0%	75%	185
Institutional support	5,400	50%	0%	50%	5,700
Subtotal	59,760				60,731
Physical contingencies @ 8%	4,781				4,858
Grand total	64,541				65,589

Note: a/ using domestic price level numeraire
Conversion factor tradable component is SERF of 1.11
Conversion factor unskilled labor is SWRF of 0.65

47. The SERF of 1.11 is used to shadow price the tradable component while the SWRF of 0.65, to shadow price the unskilled labor component. Since the domestic price numeraire is being used, non-tradables do not need further adjustment. The disbursement profile shown in Table B.7 has been used to calculate the investment in economic prices per year in Table B.12.

B.5.2.2 Operation and Maintenance

48. The operation and maintenance costs in financial terms (lines 93-98) have been converted to economic values as follows [lines 149-154]:

(i) Labor. Approximately 10 percent of the operating labor cost is unskilled labor (conversion factor 0.65) and the other 50 percent, skilled labor (conversion factor 1.00). The financial labor cost has been converted to economic by 0.965 (10% x 0.65 + 90% x 1.00);

(ii) Electricity. The national conversion factor for electricity based on the domestic price numeraire is 1.1;

(iii) Chemicals. Chemicals, such as chlorine and lime, used by the utility to treat water are traded internationally. It is assumed that 90 percent of the cost to the utility would represent the traded component, which is converted to economic by the SERF. The other 10 percent would represent the non-traded component, such as local transport and storage, which requires no adjustment. The financial cost of chemicals has been converted to economic by 1.1 (90% x 1.11 + 10% x 1);.

(iv) Other. Other operation costs, such as overhead, office utensils, small materials, has been assumed as half traded (CF 1.11) and half non-traded (CF 1.0). The financial cost has been converted to economic by 1.056 (50% x 1.11 +50% x 1.00).

B.5.2.3 Opportunity Cost of Water

49. The raw water tax of VND200 per m^3 paid to the irrigation authority underestimates the economic value of additional raw water used as an input for drinking water supply [lines 155-159]. It has been concluded that the expansion of the drinking water supply for the town prohibits the planned expansion of the irrigation scheme by 200 hectares. An assessment of the opportunity cost of water indicates that the economic value of raw water used for irrigation is approximately VND400 per m^3. The total economic benefit foregone in irrigation would be VND1.3 billion in 2005, when the water supply project demands an additional volume of 3.2 Mm^3 raw water.

Table B.12 Project Cost in Economic Prices

		unit	1996	1997	1998	1999	2006 2026
136	Investments						
137	Source development	VND mn	7,382	7,382	3,691	0	0
138	Water treatment	VND mn	987	740	740	0	0
139	Ground storage	VND mn	70	175	105	0	0
140	Elevated storage	VND mn	316	789	474	0	0
141	Pump station	VND mn	272	340	68	0	0
142	Distribution system	VND mn	3,508	10,524	1,754	1,754	0
143	Sanitation and drainage	VND mn	931	931	621	621	0
144	Consulting services	VND mn	5,335	4,268	1,067	0	0
145	Investigations	VND mn	93	74	19	0	0
146	Institutional support	VND mn	1,140	1,710	1,710	1,140	0
147	Physical contingencies @ 8%	VND mn	1,603	2,155	820	281	0
148	Total investment	VND mn	21,636	29,089	11,068	3,796	0
149	Operation & maintenance						
150	Labor	VND mn	0	247	308	335	389
151	Electricity	VND mn	0	549	668	710	710
152	Chemicals	VND mn	0	384	468	497	497
153	Other O&M	VND mn	0	474	577	613	613
154	Total O&M	VND mn	0	1,653	2,021	2,155	2,209
155	Opportunity cost of water						
156	Project water produced	'000 m^3	0	708	1,040	1,375	3,189
157	Opportunity cost of water	VND/m^3	400	400	400	400	400
158	Opportunity cost of water	VND mn	0	283	416	550	1,276
159	Project economic cost	VND mn	21,636	31,026	13,505	6,502	3,485

B.5.3 ENPV and EIRR

50. Table B.13 presents a summary of the economic benefits and costs for the Project, used to estimate the ENPV and EIRR. [lines 160-164]. The non-technical losses (10 percent of water produced) are added to the volume of project water sold to form the total project water consumed. The total volume of project water consumed is 2.9 Mm^3 in 2005.

51. The first two lines (lines 166 and 167) recapture the value of incremental and nonincremental water [lines 166-169]. The value of non-technical losses per m³ is the weighted average of the value of incremental and non-incremental water per m³. In 2005, the total value of non-technical losses amounts to VND1.8 billion (319,000 m³ x [(VND11.78 mn + VND2.79 mn)/2.697 Mm³]).

52. The net cash flow of the project is the difference between the economic benefits and costs [lines 170-175]. Discounted at 12 percent, the ENPV is positive VND5.5 billion. The EIRR is 13.1 percent, which exceeds the EOCC of 12 percent by 1.1 percent. The project is economically viable albeit marginally. A table which shows the cash flow for the entire 1996-2026 period is appended as Annex B.2.

Table B.13 EIRR and ENPV

		Unit	PV @ 12%	1996	1997	2000	2005	2006 2026
160	Project water sold	'000 m³	13,295	0	532	1,543	2,607	2,607
161	Project water produced	'000 m³	16,120	0	708	1,771	3,189	3,189
162	Non-technical losses	%		10%	10%	10%	10%	10%
163	Non-technical losses	'000 m³	1,612	0	71	177	319	319
164	Project water consumed	'000 m³	14,907	0	603	1,720	2,926	2,926
165	Gross benefits							
166	Value nonincremental water	VND mn	58,037	0	1,892	6,435	11,783	11,783
167	Value incremental water	VND mn	13,268	0	297	1,421	2,788	2,788
168	Value of non-technical losses	VND mn	8,643	0	292	902	1,783	1,783
169	Project economic benefits	VND mn	79,948	0	2,481	8,757	16,354	16,354
170	Project economic benefits	VND mn	79,948	0	2,481	8,757	16,354	16,354
171	Project economic cost	VND mn	74,455	21,636	31,026	2,872	3,485	3,485
172	Project net cash flow	VND mn	5,493	-21,636	-28,545	5,885	12,869	12,869
173								
174	EIRR		13.1%					
175	ENPV @ 12%	VNDmn	5,493					

B.5.4 Sensitivity Analysis

53. The EIRR of 13.1 percent is marginally sufficient to justify the project. Sensitivity analysis is important to test the robustness of the project under unforeseen circumstances. Table 14 assesses the impact of a change in selected parameters on the EIRR. For each parameter, the value in the base-case and two sensitivity tests are given.

54. Switching values are also calculated. A switching values is the percentage change in the parameter required to reduce the EIRR to the cut-off rate of 12 percent (i.e., EOCC).

Table B.14 Results of Sensitivity Analysis

Parameter	Unit	Base Value	Scenario Values		Switching Values (SVs)
			1	2	
SERF		1.11	1.25	1.00	23%
EIRR		13.1%	12.5%	13.6%	
SWRF		0.65	0.50	0.80	20%
EIRR		13.1%	11.8%	14.2%	
Operating life	years	30	25	20	
EIRR		13.1%	12.6%	11.7%	
Economic benefits minus		0%	10%	20%	7%
EIRR		13.1%	11.5%	9.8%	
Investment cost plus		0%	10%	20%	36%
EIRR		13.1%	12.8%	12.5%	
Water demand (1996)	lcd	100	90	85	6%
EIRR		13.1%	11.2%	10.2%	
Coverage 2000 (2005 + 10%)	% pop	70%	65%	60%	5%
EIRR		13.1%	11.5%	9.8%	
Real income growth per caput	% per year	2.5%	1.5%	0.5%	36%
EIRR		13.1%	11.9%	10.7%	
Income elasticity		0.50	0.40	0.30	62%
EIRR		13.1%	12.7%	12.4%	
Price elasticity		-0.35	-0.50	-0.60	111%
EIRR		13.1%	12.7%	12.4%	
Population growth	% per year	3.0%	2.0%	0.0%	21%
EIRR		13.1%	11.3%	7.6%	
Delay in benefits	years	0	1	2	
EIRR		13.1%	12.7%	12.1%	

55. As summarized in Table B.14, the switching values demonstrate that the project's EIRR would fall from 13.1 percent to 12 percent if:

(i) the SERF was 23 percent higher (i.e., 1.37 compared to 1.11). A higher SERF increases the economic price of traded materials used in the project;

(ii) the SWRF was 20 percent lower (i.e., .52 compared to .65). A lower SWRF reduces the economic supply cost of water replaced by the project (a benefit to the project), and reduces the economic opportunity cost of unskilled labor inputs (a cost to the project). The first effect is stronger than the second;

(iii) economic benefits fell by 7 percent;

(iv) the economic value of project assets increased by 36 percent;

(v) the existing per capita demand for piped water of 100 lcd was overestimated by 6 percent and resources to connect additional consumers were not available;

(vi) the achieved coverage in the year 2000 was 5 percent below target, so that the population coverage in 2000 would be 67 percent (95% x 70%) and in 2005, 77 percent (67% + 10%);

(vii) the real income growth per capita was reduced by 36 percent, from 2.5 percent to 1.6 percent (64% x 2.5%). A lower per capital income growth leads to a lower than expected demand, causes the economic supply cost of water displaced by the project to be lower in later years of the analysis, and reduces the value of operating labor. The first two effects affect the EIRR negatively, the third positively. The net effect is negative;

(viii) the income elasticity of demand fell by 62 percent, from .50 to 0.19 (38% x 0.50). A lower income elasticity implies that the expected increase in incomes will translate into lower additional demand than projected, and hence an oversized project;

(ix) the price elasticity of demand increased by 111 percent, from -0.35 to -0.74 (111% x -0.35). The higher (absolute) value of the price elasticity, in combination with an annual 2 percent tariff increase, would lead to a lower demand than initially foreseen;

(x) population growth was 21 percent lower than projected at 2.4 percent per annum (79% x 3%). This would cause the total demand to be less than anticipated;

(xi) and all other parameters do not change. If the lifetime of the project assets is reduced to 25 or to 20 years, the EIRR would decrease to 12.6 percent and 11.7

percent, respectively. If the project benefits were deferred by one or two years, the EIRR would decrease to 12.7 percent and 12.1 percent respectively.

B.6 SUSTAINABILITY

56. Sustainability has different dimensions, including financial, economic, environmental and institutional. A simplified test of financial sustainability of the project is assessed by comparing the average tariff with the AIFC, which is a test of the ability of the project to cover all costs, including financing charges, and make an adequate return on investment. The difference is the financial subsidy. The ADB expects that if financial subsidies are required, a justification is provided and an assessment of the ability of the government to subsidize the project is made. Sustainability analysis also involves financial analysis at the entity level. However, for purposes of this example, it is not included.

57. Most of these steps are not discussed in this section. It is limited to the calculation of the AIC and subsidies of the urban case study discussed throughout this Annex. The calculation is shown in Table 15 and Table 16. (The flows of water, costs and benefits are shown for all project years in Annex B.2.)

B.6.1 Average Incremental Financial Cost and Financial Subsidy

58. [lines 176-182] The average incremental financial cost of water is calculated by dividing the present value of the project cost at financial values by the present value of project water sold. The average tariff is calculated by dividing the present value of financial revenues by the present value of project water sold. Discounting is done at the WACC of 7 percent, which is used as a proxy of the FOCC. The flows of project water, costs and revenue have been calculated in the previous tables and are repeated here (line 176 = line 103, line 177 = line 79 and line 178 = line 57).

59. The AIFC in the example is VND3,617 per m^3 (VND85.7 billion / 23.7 Mm^3 x 1,000). The average tariff is VND3,416 per m^3 (VND81.0 billion / 23.7 Mm^3 x 1,000). The financial subsidy amounts to VND200 per m^3 (3,617 - 3,416). With the proposed tariffs, 94 percent (3,416 / 3,617) of all costs will be recovered through user charges.

Table B.15 AIFC and Financial Subsidy

		unit	PV @ 7%	1996	1997	2000	2005	2006 2026
176	Total project costs	VND m.	85,773	21,083	30,495	2,389	2,719	2,719
177	Total project revenues	VND m.	81,020	0	2,179	5,550	9,211	8,722
178	Project water sold	'000 m³	23,717	0	532	1,543	2,607	2,607
179	AIFC @ 7%	VND/m³	3,617					
180	Average tariff @ 7% (incl. connection fees)	VND/m³	3,416					
181	Financial subsidy	VND/m³	200					
182	Financial cost recovery %	VND/m³	94%					

B.6.2 Average Incremental Economic Cost and Economic Subsidy

60. The average incremental economic cost of water is calculated by dividing the present value of the project cost at economic values by the present value of project water consumed [lines 183-188]. The average tariff is calculated by dividing the present value of financial revenues by the present value of project water consumed. The quantity of water consumed includes non-technical losses. Discounting is done at the EOCC of 12 percent. The flows of project water, costs and revenues have been calculated in the previous tables and are repeated here (line 183 = line 159; line 184 = line 117 and line 185 = line 164).

61. The AIEC in the example is VND4,995 per m³ and the average tariff is VND3,073 per m³. The economic subsidy amounts to VND1,922 per m³. The most important reason for the AIEC to exceed the AIFC is the discount rate of 12 percent used.

Table B.16 AIEC and Economic Subsidy

		unit	PV @ 12%	1996	1997	2000	2005	2006 2026
183	Project economic cost	VND m.	74,455	21,636	31,026	2,872	3,485	3,485
184	Total project revenues	VND m.	45,802	0	2,179	5,550	9,211	8,722
185	Project water consumed	'000 m³	14,907	0	603	1,720	2,926	2,926
186	AIEC @ 12%	VND/m³	4,995					
187	Average tariff @ 12% (incl. connection fees)	VND/m³	3,073					
188	Economic subsidy	VND/m³	1,922					

B.7 DISTRIBUTION ANALYSIS and POVERTY IMPACT

62. In Annex B.3, a summary of the financial and economic statement of the Project is shown. For purposes of distribution analysis, the discount rate used in both statements is 12 percent. Table B.17 summarizes the present values and shows the distribution of project effects among the different participants.

63. As a result of the project, some participants loose and others gain. At a discount rate of 12 percent, the utility will suffer a loss of VND23.6 billion. The economy will suffer a loss because the overvaluation of the currency causes the financial values of traded goods to be below the economic costs by VND4.3 billion. The farming community will loose by VND3.2 billion because it is unable to extend irrigated agricultural land due to the diversion of water to the water supply project.

64. Laborers gain by VND2.5 billion because the project pays wages in excess of the economic opportunity cost of labor. The consumers will gain by VND34.1 billion because they can avail of increased quantities of water at a lower cost than without the project.

65. The distribution analysis indicates that the largest share of the gains to consumers and labor (total VND36.6 billion) are in fact paid for by the government/economy and by farmers (total VND31.1 billion). The net gain to the economy is much less than the net gain to the consumers, which is VND5.5 billion.

Poverty Impact Indicator.

66. Nationwide, 50 percent of the population is living in poverty. Poverty is more evident in rural than in urban areas; approximately 60 percent of the rural and 30 percent of the urban population are classified as poor. The socio-economic survey showed that the project town and its surrounding area show similar poverty characteristics.

Table B.17 Distribution of project effects (VND m., PVs @ 12 percent discount rate)								
			Difference	Distribution of Project Effects				
	Financial Present Values	Economic Present Values	Economic minus Financial	Utility	Gov't/ Economy	Farmers	Labor	Consumers
Benefits:								
Total project benefits	45,802	79,948	34,146					34,146
Costs:								
Project investment								
Traded element	29,523	32,803	3,280		-3,280			
Unskilled labor	6,884	4,475	-2,409				2,409	
Non-traded equipment	15,520	15,520	0		0			
Operation and maintenance								
Labor	2,616	2,524	-92				92	
Electricity	4,498	4,948	450		-450			
Chemicals	3,149	3,463	315		-315			
Other O&M	4,048	4,273	225		-225			
Opportunity cost of water	3,224	6,448	3,224			-3,224		
Total project costs	69,462	74,455						
Net benefits	-23,660	5,493	29,153	-23,660				
Gains and losses				-23,660	-4,270	-3,224	2,501	34,146

Source: Present values @ 12 percent in Annex 3.

67. For each class of beneficiary, the Project's benefits have been distributed to the poor as follows:

(i) *government/economy*: the loss of VND27.9 billion will reduce the available government funds. A budgetary assessment estimates that 40 percent of the government expenditures are targeted to the poor;
(ii) *farmers*: the loss in total of VND3.2 billion due to the downsized planned extension of the medium sized irrigation scheme by 200 hectares may be counterproductive in terms of alleviating rural poverty. Sixty percent of the beneficiaries from the existing and proposed irrigation are poor farmers.
(iii) *labor*: the gain of VND2.5 billion is a result of the project wages for unskilled labor, which are above the opportunity cost of unskilled labor. Sixty percent of unskilled labor are considered as poor;
(iv) *consumers*: the gain to the consumers is VND34.1 billion. Approximately 40 percent of the new consumers are estimated to be poor.

The poverty impact ratio for the project is calculated in Table B.18.

Table B.18 Poverty impact ratio (VND m., PVs @ 12 percent discount rate)

	Gov't/ Economy	Farmers	Labor	Consumers	Total
Gains and losses (NEB-NFB)	-4,270	-3,224	2,501	34,146	29,153
Financial return utility	-23,660				-23,660
Benefits	-27,930	-3,224	2,501	34,146	5,493
Proportion of poor	0.40	0.60	0.60	0.40	
Benefits to poor	-11,172	-1,934	1,501	13,658	2,053
Poverty impact ratio: 2,053 / 5,493 = 0.37					

68. The poverty impact ratio, which is calculated as the benefits to the poor divided by the total benefits, is 0.37 (VND2,053 m / VND5,493 m.). Compared to an urban population living in poverty of 30 percent, it is concluded that the project has a moderate poverty reducing impact for the town.

B.8 RECOMMENDATIONS

69. The project is a beneficial project, although marginally, as the EIRR is 13.1 percent. This EIRR is particularly prone to variations in assumptions underlying the total demand forecast. These assumptions include forecasts on population coverage, per capita piped water demand, income changes, income elasticity and price elasticity. The lowest switching values occur for changes in per capita water demand and population coverage. Six percent overestimated per capita demand (94 instead of 100 lcd) and a 5 percent lower than planned coverage by year 2000 (from 70 to 67 percent) reduces the EIRR to 12 percent.

70. Considering that: (i) the substantial and constrained piped water demand of 85 lcd by existing consumers, supplemented with 15 lcd of water from alternative sources against a cost which is above the cost of water form the project; and (ii) a consumption of non-piped water of 78 lcd by nonconnected households at a cost which is more than twice the cost of water with the project, a piped water demand estimate of 100 lcd is considered a reasonable and conservative estimate.

71. The population coverage target of 70 percent by 2000 (and 80 percent by 2005) is below the 85 percent of the population which stated a clear preference for piped water supply. The stated coverage targets are supply constrained and actions at the entity level could be taken to increase efficiency.

72. The project is marginally financially sustainable. The estimated costs are covered by user charges (94 percent). Operating losses, if any, might be covered by the local community. The entity could pay 6.26 percent interest on its loans, while it is estimated that 7 percent is required.