

**VIET NAM: BASIC INFRASTRUCTURE FOR INCLUSIVE GROWTH
IN THE NORTHEASTERN PROVINCES SECTOR PROJECT**

DETAILED ECONOMIC AND FINANCIAL ANALYSIS

- WATER SUPPLY

DETAILED ECONOMIC AND FINANCIAL ANALYSIS – WATER SUPPLY

A. Boc Bo Commune Water Plant, Bac Kan Province

1. Existing Situation

1. Boc Bo town is currently served to a limited degree by a piped network supplied by a pumping station located at the entrance to Bo La Cave, constructed in 2001. The system currently supplies untreated water to only 68 households out of around 670. In part because of the poor-quality water supply, water tariffs for all customer are set at a low level. Characteristics of the existing plant are outlined in Table A1.

Table A1 Existing Water Plant Connections and Tariffs

	Connections	Tariff (VND/m ³)
Year operated: 2003		
Number of households	68	2,500
Number of government agencies and business establishments	16	3,600
Total	84	

Source: PPTA consultant

2. A survey was undertaken in mid-2016 of 70 households in the villages to be served by the new water supply. The survey results relevant to financial and economic analysis are summarized in Table A2.

Table A2 Household characteristics, health and time to collect water

		Number of Households	Female headed households	%
Total survey	no	70		8
Poverty				
Very poor	no	0		
Poor	no	25		36%
Near poor	no	12		17%
Non- poor	no	33		47%
Total	no	70		100%
Households with health problems in the last year				
Having sore eyes	%	37%		
Diarrhea/dysentery	%	23%		
Skin disease	%	23%		
Income per HH				
Income from crops	Đ'000	9,455	10,166	
Income from Livestock	Đ'000	18,217	14,201	
Other income	Đ'000	5,238	12,000	
Total income	Đ'000	32,910	36,368	
Responsible for fetching water				
Wife	no	9		13%
Husband	no	14		20%
Both husband and wife	no	0		0%
Girls	no	0		0%
Boys	no	4		6%
Total	no	27		39%
Travel time to water source				
In yard at house	no	62		7
Less than 15 minutes	no	4		1
From 15 to 30 minutes	no	4		
Frequency of water collection				
Daily	no	3		
Twice a day	no	1		

		Number of Households	Female headed households	%
3 times a day	no	2		
every second day	no	1		
less than every second day		5		1
Average travel time/trip each way	mins	15.0		7.5
Average trips per day	no	1.2		0.3
People making trips	mins	10		1
Overall average time per household in total population	mins	5.0		0.5
Water to yard %	%	89%		88%

Source: PPTA consultant

3. Some notable features of the survey are as follows:
- All three disease (sore eyes, diarrhea, skin disease) occur frequently. In particular, 37% of households reported incidences of sores eyes, and 23% reported incidences of diarrhea.
 - Female-headed households report 10% higher household income than male-headed. Collection of water from outside the yard is mainly the responsibility of men and boys.
 - 89% of households reported that they had water to the yard.
 - The 8% of houses that need to collect water spend an average of 32 minutes per day on this activity. Averaged over the survey sample, this translates to 4.1 minutes per household. However, a follow-up survey revealed that, during the dry season, households spend significantly more time on water collection than was indicated by the initial survey. When seasonal variation is taken into consideration, households actually spend 12.4 minutes per day on water collection.

Table A3 Attitudes to present and future water supply

Satisfaction with current water supply (% responding positively)	% of households
a) Does your current water supply/ collection satisfy your daily need?	76%
b) Is your water source reliable all year round in terms of quantity?	63%
c) Does it take you longer to collect water or do you have to travel to a different location to collect water during dry season?	20%
d) Is your water source reliable all year round in terms of quality?	13%
e) Is your water source contaminated or in danger of being polluted?	36%
g) Has water availability been decreasing over the years?	36%
h) Do competing needs for water create conflicts in the community?	11%
i) Is there a water management committee in this village?	3%
j) If there is a water management committee do you participate?	11%
n) Do all socio-economic groups have equal access to water?	77%
o) Do both women and men have equal access to water?	83%
Willingness to Pay for water	
Do you pay for water now?	0%
Do you think that most people can afford to pay for water?	29%
Are you willing to pay for improved water?	70%

Source: PPTA consultant

4. Key findings from the survey include:
- 20% report that dry season water collection of water varies from that in the wet season.
 - 76% of respondents believe that their water supply system meets their daily needs. However only 13% think that water quality is adequate year-round.
 - 36% think that their water is currently or will become polluted.
 - 36% consider that water availability has decreased.
 - Only 29% of respondents believed that most people can afford to pay for water, but 70% reported that their household would be willing to pay for water.

2. New Water Plant

5. The subproject will develop a new water supply system to serve Boc Bo town, Pac Nam district and 5 of the 9 villages in Boc Bo commune. With a designed capacity of 1,340 m³/day, the water treatment plant is designed to fulfill future demand until 2030. By then, the plant will supply to 1,081 households, 30 government agencies and 15 business establishments, totaling 1,126 paying customers (Table A4). At construction completion (2020), the plant will provide service to 788 customers, or 70% of the total number of customers at 2030. Overtime, new customers will subscribe and defray the connection costs, of about VND2 million per connection. In addition to the 1,081 paying or metered households, there will be about 105 non-paying of non-metered households. While these non-paying households will not contribute to the water company's profitability, the benefits of their consumption are captured in the economic analysis.

6. Equivalently, in terms of water volume, the plant will supply an average of 757 m³/day. Annual water sales are expected to be 276,305 m³ per year, plus 15% (113.5m³/day) of non-revenue water consumed by non-paying households.

Table A4 Derivation of New Water Plant Capacity and Connection Target

	Derivation	m3/day	Connections
Population by 2030: 4,791			
Quantity for domestic consumption (Qh)		582	1,081
Quantity for public use (Qg)	= 10%*Qh	58	30
Quantity for business establishments (Qb)	= 20%*Qh	116	15
Total quantity for average water use per day (ADD)	= (Qh+Qg+Qb)	757	1,126
Water lost (NRW)	= 15%*ADD	114	105
Water use capacity per day in the pipeline network (Qm) = (ADD+NRW)		870	
Water for the plant itself (Qp)	= 10%*Qm	87	
Average capacity per day (ADP)	= (Qm+Qp)	957	
Max capacity per day (MDP)	= 1.4*ADP	1,340	

Source: ADB

7. **Investment Cost.** Investment cost is estimated at VND25.6 billion or US\$1.15 million (Table A5), equivalent to US\$1,016 per connection at full development. Rehabilitation cost was estimated to be 2% every five years, based on discussion with Lang Son Water Supply company, which had provided estimated a lower figure.

Table A5 Boc Bo Water Plant Investment Cost

	Financial Cost		Decomposition		Economic Cost		
	VND mil	\$'000	Local (%)	Foreign (%)	Local \$'000	Foreign \$'000	Total \$'000
Construction costs							
Materials	10,080	451	80%	20%	343	90	433
Labor	4,545	203	100%	0%	193	0	193
Equipment	2,282	102	30%	70%	29	71	101
Subtotal	16,907	756			565	162	727
Equipment costs	326	15	30%	70%	4	10	14
Management costs	328	15	90%	10%	13	1	14
Consultancy	1,848	83	80%	20%	63	17	79
General costs and training	576	26	90%	10%	22	3	25
Contract Management	174	8	100%	0%	7	0	7
Peripheral electricity costs	909	41	70%	30%	27	12	39
Land compensation	80	4	100%	0%	3	0	3
Tax (10%)	2,323	104	100%	0%	0	0	0
Contingency cost	2,115	95	79%	21%	71	20	91
Total	25,586	1,145				225	1,000

Source: PPTA consultant

8. **Operating Cost.** For the Bac Kang subproject, the operating costs are based on the existing Vinh Quang (Ha Giang) water plant's operating costs (Table A6). Overheads in the new plant is 75% of the Vinh Quang level due to its smaller size. Of the variable cost items, electricity cost can be reduced to 36% because water delivery will rely on gravity flow, but chemical cost will increase to 150% because of higher treatment cost associated with higher turbidity of water source. In the calculation, the unit variable cost (VND/m³) is multiplied with the expected annual sales (276,305 m³) to derive the variable operating costs.

Table A6 Existing Vinh Quang Water Plant Operating Costs

	Amount (VND mil)	Composition		Overhead (VND mil)	Variable (VND mil)	Variable (VND/m ³)
		Overhead (%)	Variable (%)			
Costs						
Electricity	307.6	0%	100%	0.0	307.6	2,129.6
Chemicals/materials	156.4	0%	100%	0.0	156.4	1,082.8
Wages	315.3	50%	50%	157.7	157.7	1,091.4
Oncosts	118.9	50%	50%	59.4	59.4	411.4
Office costs	33.8	100%	0%	33.8	0.0	0.0
Tools office/plant	22.2	55%	45%	12.2	10.0	69.7
Repairs	21.9	0%	100%	0.0	21.9	151.8
Other operating	13.4	0%	100%	0.0	13.4	92.5
Total operating costs	989.5			263.1	726.4	5,029
Tax	108.3	27%	73%	29.2	79.0	550.4

Source: PPTA consultant

9. Average tariff in 2020 is estimated at VND7,000, expressed in 2016 prices, VND500 lower than the prices assumed for the tariff charged by the new Vinh Quang (Ha Giang) and Xuan Hoa (Cao Bang) water plants, in recognition of the rural nature of the commune.¹

10. Since water sales depends on the tariff, care is taken to ensure that adequate water supplies are provided at an affordable price. Affordability is assessed in Table A7, which indicates that water consumption from the water plant at the level and cost indicated will account for 4.6% of estimated household income in 2030. While this is close to the maximum level often taken as acceptable (of 5%), it is likely that the socio-economic survey underestimated income, particularly in the town where many households include salary earners. It is noted that under the Vietnamese welfare system, there are major advantages to underreporting income. Further work on income levels is desirable during implementation to ensure that tariffs meet the affordability criteria.

Table A7 Project affordability analysis

Ethnicity/ economic status		Income 2016	Increase in real income (%/year)	Income 2020	Income 2030
Survey households	VND'000	34,264	5%	41,649	58,604
Average cost of water per household	VND'000			1,833	2,425
As % of household income	%			4.4%	4.1%

¹ On a side note: in other subprojects, there is strong support for pro-poor lifeline tariff, which in fact is already used in Lang Son utilities. If specific assessment were conducted in Boc Bo, full support can be anticipated from the focus groups. The lifeline tariff may be vulnerable to abuse if households limit water consumption below the threshold level, but it is a good way to encourage households to use the water plant's treated water, particularly for those that have own supplies at the yard. While lifeline tariffs may affect the plant's financial performance in the short term, it can improve long-term financial viability in additional to providing essential water to the poor beneficiaries. In the EFA, lifeline tariff is not modelled.

11. Real tariff increases will be required to ensure the financial sustainability of the plant. The analysis assumes that tariff will increase once every three years, as is the case in practice. Each time the percentage increase is 15% in real terms. The proposed frequency and magnitude of raise seem affordable given that Bac Kan's GDP is expected to grow at 7% per year in the 2020s. An alternative to tariff rise would be for the Provincial People's Committee (PPC) to subsidize the plant. It is anticipated that the existing water plant will continue to provide water during 2019, but will close as soon as the new plant opens. The existing plant will serve as a backup system.

12. On these assumptions, the water plant would generate a financial internal rate of return (FIRR) of 2.5% over the 25-year assumed plant life (Table A8).

Table A8 Financial Analysis

	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-42	2043
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12-24	Yr 25
Revenue														
Tariff increase (real)	%	0%	15%	0%	0%	15%	0%	0%	15%	0%	0%	15%	0%	0%
Average tariff	VND/m3	0	7,475	7,475	7,475	8,596	8,596	8,596	9,886	9,886	9,886	11,369	11,369	11,369
Average water sales per day														
Construction year (old plant)	'000 m3													
Revenue water available for sales per day	m3/day	0	530	556	584	613	638	657	677	697	718	739	754	754
Revenue water available for sales per year	m3	0	193,347	203,014	213,165	223,823	232,776	239,759	246,952	254,360	261,991	269,851	275,248	275,248
Total Revenue	VND mil	0	1,445	1,518	1,593	1,924	2,001	2,061	2,441	2,515	2,590	3,068	3,129	3,129
Operating Costs														
Fixed costs														
Overheads	VND mil	0	197	201	201	201	201	201	201	197	197	197	197	197
Variable costs														
Electricity (36% of HG/m3)	VND mil	0	148	156	163	172	178	184	189	195	201	207	211	211
Chemicals (150% of HG/m3)	VND mil	0	314	330	346	364	378	389	401	413	426	438	447	447
Wages	VND mil	0	211	222	233	244	254	262	270	278	286	295	300	300
Oncosts	VND mil	0	80	84	88	92	96	99	102	105	108	111	113	113
Office costs	VND mil	0	0	0	0	0	0	0	0	0	0	0	0	0
Tools office/plant	VND mil	0	13	14	15	16	16	17	17	18	18	19	19	19
Repairs	VND mil	0	29	31	32	34	35	36	37	39	40	41	42	42
Other operating	VND mil	0	18	19	20	21	22	22	23	24	24	25	25	25
Total Operating Costs	VND mil	0	1,011	1,055	1,098	1,143	1,181	1,210	1,240	1,268	1,300	1,333	1,355	1,355
Tax	VND mil	0	106	112	117	123	128	132	136	140	144	149	151	151
Operating Cash Flow	VND mil	0	328	350	378	658	692	719	1,065	1,107	1,146	1,587	1,622	1,622
Investment Costs														
Capital expenditure	VND mil	-25,586	0	0	0	0	0	0	0	0	0	0	0	0
Rehabilitation (2% every 5 years)	VND mil	0	0	0	0	0	-512	0	0	0	0	-512	0	0
Residual (40% in Yr 25)	VND mil	0	0	0	0	0	0	0	0	0	0	0	0	10,234
Investing Cash Flow	VND mil	-25,586	0	0	0	0	-512	0	0	0	0	-512	0	0
Net Cash Flow	VND mil	-25,586	328	350	378	658	180	719	1,065	1,107	1,146	1,075	1,622	1,622
FIRR	%	2.5%												

Source: PPTA consultant

3. Economic Analysis

A. Project Costs and Conversion to Economic Value

13. The economic and financial values of any item will differ when a tax is imposed on it, or due to exchange rate distortion arising from trade taxes or subsidies and other non-tariff barriers to trade. To conduct economic cost-benefit analysis, all investment and operating cost items must be converted from financial to economic values by first netting out the taxes and then applying the appropriate conversion factors for the tradable and non-tradable components. Since the project benefit estimates were collected in the field, they are first expressed in local financial values. They must be converted to economic values using the methodology applied to financial costs.

14. The following assumptions are used in the conversion and analysis:

- a. The assumed project life is 25 years including a one-year investment period;
- b. All items are in 2017 constant price;
- c. A general rate of value-added tax (VAT) is 10% in Vietnam; an additional 5% of tariffs is deducted from tradable components;
- d. The analysis is based on world price (US\$) numeraire, to be consistent with the analysis for the road subprojects;
- e. The exchange rate is VND22,350 to US\$1.00;
- f. A shadow wage factor (SWF) of 1.00 is applied to the salary of the water plant employees, who are mostly skilled or semi-skilled;
- g. A shadow wage factor (SWF) of 0.90 is applied to time value of beneficiary households;
- h. Further adjustment is required since the analysis uses world price (US\$) numeraire. A standard conversion factor (SCF) of 0.95 is applied to non-tradable components and labour;²
- i. The social cost of capital is taken to be 9.0%.

15. **Economic Costs.** The economic value of the subproject investments is already given in Table A5. As for the operating cost items, they are presented in their financial values in Table A6. For labor, as stated a SWF of 1.00 applies because most employees are either skilled or semi-skilled. For electricity, adjustment is also required since it is subsidized. For the other items, they are already net of taxes in Table A6. To convert to the world price numeraire, the SCR is applied to all items that were in VND, including all non-tradable component and labour.

16. **Economic Benefits.** Three sources of project benefits are considered: the economic value of water for water users comprising of individual households, government agencies and business establishments.

17. Water users' willingness to pay (WTP) for treated and a reliable water supply. For paying users, the WTP is assumed to be 10% of the water tariff. A general estimate on households' willingness to pay (WTP) was undertaken during the socio-economic surveys, which suggested that households are willing to pay at least 5% more than the proposed tariffs, which translates to a WTP of 105% of proposed tariffs. The 5% premium is validated during focus group discussions. Since the tariffs are set to ensure affordability for households, the WTP for other water user groups, namely business establishments and government agencies, must be significantly greater than 105% of the proposed tariffs. In the economic analysis, the WTP is taken to be 110% of the tariffs. Recall that the plant will supply 15% of non-revenue

² The SCF of 0.95 was confirmed as current for Viet Nam by reference to the country profile of the World Trade Organization website.

water. For non-paying users, which are individual households, their WTP is taken to be half of the paying users' WTP. The economic value of water is derived by multiplying the WTP by the quantity of water consumption of each user groups.

18. **Health benefits.** Health benefits are estimated based on the reported incidence of waterborne disease in the survey, the expected time off work and cost of medicine. Health issues in the area are higher than in other subproject areas, with 23% of households reporting problems with diarrhea in the previous 12 months. Sore eyes were reported by 37% of households, with many likely to be water related. The time off work for diarrhea is 2 days, and for sore eyes is 7 days. The average cost of medication for each incident of disease VND 150,000. It is expected that, in the with-project scenario, the reported incidence of disease will be reduced 75% owing to availability of treated water.

19. **Time savings.** From the socio-economic survey, on average households spend 7 minutes per day on water collection. This figure however was questioned by Bac Kan's Department of Planning and Investment (DPI) during the interim report workshop. Consequently, a larger survey was undertaken to gauge the potential time savings, including savings from collecting water from the yard when water is available, and from collecting water from river during dry season. The time saving was thus increased to 12.4 minutes per day. The value of time is estimated at 60% of the daily rural wage, which is VND150,000.

Table A9 Project Benefits

Value of time			
Rural daily wage (8 hours)	VND/work day	150,000	
Value of time (as % of wages)	%	60%	
Value of time (VT) ^a	VND/work day	90,000	
Benefit 1: WTP of different user groups			
As % of proposed (tariff)	%	110%	
Tariff	VND/m ³	7,475	
Total WTP	VND/m ³	\$8,223	
Benefit 2: Health Benefits			
Common water-borne disease (without-project)			
% of household affected (β_{wo})	%	<u>Redeye</u>	<u>Diarrhea</u>
Days off-work (D)	days/incident	37%	23%
Medication costs (M)	VND/incident	7.0	2.0
Total cost per household [$C_{wo} = \beta_{wo} * (D * VT) + M$] ^b	VND/incident	150,000	150,000
		288,600	75,900
	%	75%	75%
Reduction in disease incident (with project)			
% of household affected ($\beta_w = 75% * \beta_{wo}$)	%	9.3%	5.8%
Total cost per household [$C_w = \beta_w * (D * VT) + M$] ^b	VND/incident	72,150	18,975
Reduction in health costs per household (R = C_{wo} - C_w)	VND/HH	216,450	56,925
Benefit 3: Water collection time savings			
Time spent on water collection (M)	min/day/HH	12.4	
Time savings (workday equivalence, T = M/480 minutes)	day/household	0.03	
Time cost savings (S = T*VT)^b	VND/day/HH	2,325	

Source: PPTA consultant

20. Where applicable, the various benefit streams (i.e., willingness to pay, time savings from avoided day off work due to sickness; medicine cost savings; time savings from water collection) are first net of taxes, and then adjusted by the SWF for beneficiaries' time value, and also by the SCF for all non-tradable components, since the analysis is in world price numeraire.

21. Based on the aforementioned methodology and assumption, the economic internal rate of return (EIRR) is 9.4% (Table A10). Sensitivity analysis was undertaken to assess the EIRR under different circumstances, including (i) investment cost overrun, (ii) operating costs overrun; (iv) reduction in project benefits; (v) reduction in new connections.

Table A10 Sensitivity Analysis

Sensitivity Test	FIRR (%)	ENPV (million US\$)	EIRR (%)	SI (%)	SV
Base Case	2.1%	82.2	9.4%		
+10% investment cost	1.6%	-100.3	8.5%	-1.001	-1.0
+10% operating costs	1.8%	27.6	9.1%	-0.312	-3.2
-10% benefits	2.1%	19.0	9.1%	-0.361	-2.8
-10% new connection	2.1%	29.1	9.2%	-0.302	-3.3

FIRR = financial rate of return; ENPV = economic net present value; EIRR = economic internal rate of return; SI = sensitivity Index; SV = switching value

Source: PPTA consultant

Table A11 Economic Analysis

		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-42	2043
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12-24	Yr 25
Economic Benefits														
Economic value of water	VND mil		1,653	1,736	1,823	2,201	2,289	2,357	2,792	2,876	2,962	3,509	3,579	3,579
Health benefit	VND mil		192	202	212	222	231	238	245	252	260	268	273	273
Time Savings	VND mil		637	668	702	737	766	789	813	837	862	888	906	906
Total Economic Benefits	VND mil		2,482	2,606	2,736	3,160	3,286	3,385	3,850	3,966	4,085	4,665	4,758	4,758
Economic Costs														
Operating Costs														
Fixed costs														
Overheads	VND mil		187	191	191	191	191	191	191	187	187	187	187	187
Variable costs														
Electricity (36% of HG/m3)	VND mil		169	177	186	196	203	210	216	222	229	236	241	0
Chemicals (150% of HG/m3)	VND mil		298	313	329	345	359	370	381	392	404	416	425	0
Wages	VND mil		200	210	221	232	241	249	256	264	272	280	285	0
Oncosts	VND mil		76	79	83	87	91	94	97	99	102	105	108	0
Office costs	VND mil		0	0	0	0	0	0	0	0	0	0	0	0
Tools office/plant	VND mil		13	13	14	15	15	16	16	17	17	18	18	0
Repairs	VND mil		28	29	31	32	34	35	36	37	38	39	40	0
Other operating	VND mil		17	18	19	20	20	21	22	22	23	24	24	0
Total Operating Costs	VND mil		988	1,032	1,074	1,118	1,156	1,185	1,214	1,241	1,273	1,305	1,328	1,328
Tax	VND mil													0
Total Operating Costs	VND mil		1,176	1,223	1,266	1,310	1,347	1,376	1,405	1,429	1,460	1,493	1,515	1,515
Net Economic Benefits	VND mil		1,306	1,382	1,470	1,850	1,939	2,009	2,445	2,537	2,625	3,172	3,243	3,243
	\$'000		58	62	66	83	87	90	109	114	117	142	145	145
Investment Costs														
Capital expenditure	\$'000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0
Connection fee of new customers	\$'000	0	0	-3	-3	-4	-3	-2	-2	-2	-3	-3	-2	0
Rehabilitation (2% every 5 years)	\$'000	0	0	0	0	0	-20	0	0	0	0	-20	0	0
Residual (40% in Yr 25)	\$'000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	400
Investing Cash Flow	\$'000	-1,000	0	-3	-3	-4	-23	-2	-2	-2	-3	-23	-2	0
Net Economic Resource Flow	\$'000	-1,000	58	59	62	79	64	88	107	111	115	119	143	145
ENPV	\$'000	33.33												
EIRR	%	9.35%												

Source: PPTA consultant

B. Ha Quang District Water Plant, Cao Bang Province

1. Existing Situation

1. The subproject proposed for Ha Quang district in Cao Bang province will replace the current plant in Xuan Hoa town with a new water plant located on the Na Dam stream between the town and Phu Ngoc commune.

2. The current plant was constructed in 2001 and was supported for a while by the Cao Bang Water Supply Company. It closed for a period from 2003 onwards when its network was disrupted by major roadworks. Since 2007 it has been managed for the District People's Committee (DPC) by the Environment Sanitation and Water Supply Cooperative (ESWSC) but is suffering from several problems, and is now delivering untreated water from a polluted source. DPC plans to close the plant as soon as the new treatment plant opens. Characteristics of the existing plant are outlined in Table B1.

Table B1 Existing water plant performance

	Tariff (Đ/m ³)	Sales (m ³ /year) (m ³ /day)	Supply (liter/day)
Households	3,600	24,216	66
Businesses	4,700	5,607	15
Government + Businesses	7,000	5,820	16
Total	5,170	35,643	98

n/a = non-available

Source: PPTA consultant

2. Socio-economic Survey Results

3. A survey was undertaken in mid-2016 of 100 households in the town and commune to be served by the new water supply. The survey results relevant to financial and economic analysis are summarized in Table B2.

Table B2 Household characteristics, health and time to collect water

	Units	Xuan Hoa town	Phu Ngoc Commune	Total
Total Survey	no	50	50	100
Female Headed Households	no	6	15	21
Poverty				
Poor	%	36%	34%	35%
Near Poor	%	18%	20%	19%
Non- poor	%	46%	46%	46%
Total	%	100%	100%	100%
Income per HH				
Income from crops	Đ'000	10397	23391	16894
Income from Livestock	Đ'000	8976	13504	11240
Other income	Đ'000	9794	6364	8054
Total income	Đ'000	29168	43259	36188
Households with health problems in the last year				
Having sore eyes	%	22%	10%	16%
Diarrhea /dysentery	%	12%	2%	7%
Skin disease	%	24%	12%	18%
Travel time to water source				
In yard at house	no	47	42	89
Less than 15 minutes	no	1	6	7
From 15 to 30 minutes	no	2	1	3
From 30 to 60 minutes	no	0	1	1
Frequency of water collection				
Daily	no	0	1	1
3 times a day	no	12	13	25
every second day	no	0	2	2

	Units	Xuan Hoa town	Phu Ngoc Commune	Total
less than every second day	no	0	0	0
Average travel time/trip each way	no	17.5	14.1	15.0
Average trips per day	no	3.0	2.5	2.7
Average time per day for those houses collecting water	mins	105.0	70.3	81.4
Overall average time per household in total population	no	6.3	11.3	9.0
Water to yard %		94%	84%	89%

Source: PPTA consultant

4. Some notable features of the survey are as follows:
- The similar levels of poverty between town and commune, despite income in the commune being reported as almost 50% higher than in town.
 - All forms of potentially water related disease in town are at least double those of the commune.
 - Only 6% of town residents reported a need to travel to collect water. While this took a total of 105 minutes per day, when averaged over the total stratum, time per household was 6 minutes. In the commune 16% reported travelling to collect water, with average time for the whole stratum averaging 11 minutes/day.

Table B3 Attitudes to present and future water supply

Satisfaction with current water supply (% responding positively)	Xuan Hoa town	Phu Ngoc commune	% of households
Satisfaction with current water supply			
a) Does your current water supply/ collection satisfy your daily need?	%		64%
b) Is your water source reliable all year round in terms of quantity?	%		41%
c) Does it take you longer to collect water or do you have to travel to a different location to collect water during dry season?	%		42%
d) Is your water source reliable all year round in terms of quality?	%		14%
e) Is your water source contaminated or in danger of being polluted?	%		48%
g) Has water availability been decreasing over the years?	%		60%
h) Do competing needs for water create conflicts in the community?	%		30%
i) Is there a water management committee in this village?	%		43%
j) If there is a water management committee do you participate?	%		23%
l) Do you think that most people can pay for water?	%		92%
m) Are you willing to pay for improved water from this project?	%		97%
n) Do all socio-economic groups have equal access to water?	%		87%
o) Do you think that both women and men have equal access to water?	%		98%
Expected benefits from improved water supply scheme			
a) Save time	%	8%	30%
b) Lessen work burden	%	14%	4%
c) Provide better cleaner environment for household generally	%	34%	26%
d) Less illness and disease for family	%	62%	48%
e) Will have enough water to satisfy family needs	%	82%	92%
Willingness to pay for water			
Do you pay for water now?	%	8%	36%
Do you think that most people can afford to pay for water?	%	96%	88%
Are you willing to pay for improved water?	%	100%	94%

Source: PPTA consultant

5. Notable points from the table include:

- Overall, 64% of respondents believed that their water supply met their daily needs, though only 41% were satisfied with year-round quantity, and a low 14% with quality. Nearly half feared that their water source is or will become polluted.
- A high 60% believed that water availability has been decreasing.
- In relation to the new plant, the number expecting to save time or lessen their work burden were low, at 19% and 9% respectively.
- 30% anticipated an improved environment, and a high 55% anticipated lower disease levels.
- 22% reported that they were paying for water (almost all in the commune). Since only 4% were connected to the town water supply, it is likely that the other 10% would be buying 20L containers from time to time.
- Almost all respondents (97%) indicated that they would be willing to pay for water from the new plant.

6. Following the survey, two focus group discussions were held in Cao Bang province on 8 November 2016.

Table B4 Summary of focus group outcomes, Ha Quang district, Cao Bang

	Xuan Hoa town	Phu Ngoc commune
Number in Focus group discussion	8	9
Average adults/HH	3.6	3.8
Children	1.1	0.9
Family size	4.7	4.7
Water piped to house		
Network	2	-
Own system	5 (2-10 HH/system)	1 (40+school)
Well	4 individual, 1 shared (4)	3 individual, 5 shared (2-3 HH)
Rainwater	Not known but likely	
Tanks	Most have 1.2 m ³ metal	
Cost of water system		
Constructed	Đ1 mil/HH	2005/06
Cost to repair	Đ50-100k/HH/y	Đ2.5 mil new pump lasts 3 years 1 HH Collected by motor bike – 40L once per week
Water from stream		1 HH buys 20L Đ25k, lasts 2 days.
Purchased		Others buy sometimes
Water demand m ³ /d	Wet season 350L/HH/d Dry season pipe systems decline to maybe 250 L/HH	
Average income/HH/year	Đ84 mil	Đ45 mil
Expressed WTP/m ³		
Tariff Đ5k/m ³	Max amount Đ100-200k/HH/month	1 m ³ /d
Đ10k/m ³	All would buy, but less	Reduce to around 500L/d
Đ15k/m ³	Little	No-one would buy
WTP for connection	Đ1.5-2 mil ok, 3 mil refuse	
Support pro-poor pricing	100%	100%
Health		
Diarrhea	2 children/6 adults No loss of work time	1 child but not water related 10% suffer kidney stones, may be due to hard water?
Redeye	none	
Days lost total	no loss worktime	
Cost medicine	Đ200k	
Comments	No worktime lost due to child illness	

Source: PPTA consultant

7. 5 of the 8 town FGD participants had two sources of water to or near the yard. All had at least one. Three respondents considered their water supply to be of good quality, the rest, bad – including the two network water users.

8. The kidney stones reported in Phu Ngoc are of interest, though 10% is within normal expectation. If a link to hard water can be demonstrated, then support would be needed to install water softeners for drinking and cooking water.

3. New Water Plant

9. The new plant has a design capacity of 2000 m³/day, allowing average daily sales at full development are estimated at 1235 m³, allowing for seasonal variations in demand. It is expected that this will be sufficient to meet demand in 2030, with a total of 2,453 connections (Table B5)

Table B5 Estimated demand by 2030

	Xuan Hoa town	Phu Ngoc commune	Total
Population	5,449	4,228	9,677
Number of households	1,330	1,073	2,403
Number of government offices	35	5	40
Number of businesses	8	2	10
Total customers (with meters)	1,373	1,080	2,453

Source: PPTA consultant

10. In addition to the 1,081 paying or metered households, there will be about 105 non-paying (9.75%) of non-metered households. While these non-paying households will not contribute financially to the water company's, the benefits of their consumption are captured in the economic analysis.

11. **Investment Cost.** Investment cost is estimated at VND51.5 billion (US\$2.31 million). Rehabilitation cost is estimated to be 2% every five years, based on discussion with Lang Son Water Supply company, which had provided estimated a lower figure.

Table B6 Boc Bo Water Plant Investment Cost

	Financial Cost		Decomposition		Economic Cost		
	VND mil	\$'000	Local (%)	Foreign (%)	Local \$'000	Foreign \$'000	Total \$'000
Construction costs							
Materials	23,391	1,047	80%	20%	795	209	1,005
Labor	8,539	382	100%	0%	363	0	363
Equipment	3,153	141	30%	70%	40	99	139
Subtotal	35,082	1,570			1,199	308	1,507
Equipment costs	591	26	30%	70%	8	19	26
Management costs	609	27	90%	10%	23	3	26
Consultancy	3,300	148	80%	20%	112	30	142
General costs and training	1,105	49	90%	10%	42	5	47
Contract Management	337	15	100%	0%	14	0	14
Peripheral electricity costs	909	41	70%	30%	27	12	39
Land compensation	644	29	100%	0%	27	0	27
Tax (10%)	4,677	209	100%	0%	0	0	0
Contingency cost	4,258	190	80%	20%	145	38	183
Total	51,511	2,305				414	2,011

Source: PPTA consultant

12. **Operating Cost.** The operating costs are based on the existing Vinh Quang (Ha Giang) water plant's operating costs. The total overhead cost is VND 263.1 million. The

variable unit cost of each input (Table B7, last column) are multiplied with water production to yield the total variable cost.

Table B7 Existing Vinh Quang Water Plant Operating Costs

	Amount (VND mil)	Composition		Overhead (VND mil)	Variable (VND mil)	Variable (VND/m ³)
		Overhead (%)	Variable (%)			
Costs						
Electricity	307.6	0%	100%	0.0	307.6	2,129.6
Chemicals/materials	156.4	0%	100%	0.0	156.4	1,082.8
Wages	315.3	50%	50%	157.7	157.7	1,091.4
Oncosts	118.9	50%	50%	59.4	59.4	411.4
Office costs	33.8	100%	0%	33.8	0.0	0.0
Tools office/plant	22.2	55%	45%	12.2	10.0	69.7
Repairs	21.9	0%	100%	0.0	21.9	151.8
Other operating	13.4	0%	100%	0.0	13.4	92.5
Total operating costs	989.5			263.1	726.4	5,029
Tax	108.3	27%	73%	29.2	79.0	550.4

Source: PPTA consultant

4. Financial Performance

13. Average tariff in 2021 is estimated at VND8,050/m³ (the construction year, expressed in 2016 prices). Real price increases thereafter will be required to ensure the profitability of the plant and its ability to meet its debt service requirements. It is anticipated that the existing water plant will continue to provide water during 2019, the scheduled construction year, but will close as soon as the new plant opens.

14. Water production costs are estimated based on those of the current Vinh Quang plant, adjusted for reduced electricity and chemical costs. The without project water provision estimate is limited to the existing plant supply to 2028. No calculation has been made of customers' own pipeline or dug well supplies, partly because no data are available and the recognition by focus group participants that they are keen to buy a significant proportion of their water needs from the plant, for both convenience and health reasons. On these assumptions, the water plant would generate a financial internal rate of return of 2.5% over the 25-year assumed plant life (Table B7). This performance is slightly worse than the similarly sized Vinh Quang plant in Ha Giang, since both electricity and chemical costs are significantly higher, while capital cost is almost the same.

Table B8 Financial Analysis

	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-42	2031
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12-24	Yr 13
Revenue														
Tariff increase (real)	%	0%	15%	0%	0%	15%	0%	0%	15%	0%	0%	15%	0%	0%
Average tariff	VND/m3	0	8,050	8,050	8,050	9,258	9,258	9,258	10,646	10,646	10,646	12,243	12,243	11,369
Average water sales per day														
Construction year (old plant)	'000 m3													
Revenue water available for sales per day	m3/day	0	864	951	998	1048	1100	1155	1213	1235	1235	1235	1235	754
Revenue water available for sales per year	m3	0	315,418	346,960	364,308	382,523	401,649	421,732	442,819	450,789	450,789	450,789	450,789	275,248
Total Revenue	VND mil	0	2,539	2,793	2,933	3,541	3,718	3,904	4,714	4,799	4,799	5,519	5,519	3,129
Operating Costs														
Fixed costs														
Overheads	VND mil	0	197	201	205	209	214	218	222	222	222	222	222	197
Variable costs														
Electricity (36% of HG/m3)	VND mil	0	114	126	132	138	145	153	160	163	163	163	163	211
Chemicals (150% of HG/m3)	VND mil	0	683	751	789	828	870	913	959	976	976	976	976	447
Wages	VND mil	0	344	379	398	417	438	460	483	492	492	492	492	300
Oncosts	VND mil	0	130	143	150	157	165	173	182	185	185	185	185	113
Office costs	VND mil	0	0	0	0	0	0	0	0	0	0	0	0	0
Tools office/plant	VND mil	0	22	24	25	27	28	29	31	31	31	31	31	19
Repairs	VND mil	0	48	53	55	58	61	64	67	68	68	68	68	42
Other operating	VND mil	0	29	32	34	35	37	39	41	42	42	42	42	25
Total Operating Costs	VND mil	0	1,568	1,709	1,788	1,871	1,959	2,050	2,146	2,181	2,181	2,181	2,181	1,355
Tax	VND mil	0	174	191	201	211	221	232	244	248	248	248	248	151
Operating Cash Flow	VND mil	0	798	893	944	1,459	1,539	1,622	2,325	2,370	2,370	3,090	3,090	1,622
Investment Costs														
Capital expenditure	VND mil	-51,511	0	0	0	0	0	0	0	0	0	0	0	0
Rehabilitation (2% every 5 years)	VND mil	0	0	0	0	0	-1,030	0	0	0	0	-1,030	0	0
Residual (40% in Yr 25)	VND mil	0	0	0	0	0	0	0	0	0	0	0	0	20,604
Investing Cash Flow	VND mil	-51,511	0	0	0	0	-1,030	0	0	0	0	-1,030	0	0
Net Cash Flow	VND mil	-51,511	798	893	944	1,459	508	1,622	2,325	2,370	2,370	2,060	3,090	3,090
FIRR	%	2.5%												

Source: PPTA consultant

15. It is also noted that water sales will be price-dependent, and that care is needed to ensure that adequate water supplies are provided at an affordable price. Affordability is assessed in Table B8, which indicates that water consumption from the water plant at the level and cost indicated will cost 3.4% of household income on average, below the maximum desirable level of 5% (see McIntosh 2003). It is noted that the focus groups held on 8 November 2016 indicated a far higher income, averaging Đ84 million for Xuan Hoa town and Đ45 million for Phu Ngoc commune thus averaging Đ64 million compared to the Đ36 million estimated from the socio-economic survey. While it is not possible to assess which is more accurate at this stage, there are reasons why the focus groups seem to generate higher stated incomes including (i) that individual's responses are not specifically recorded and (ii) the group director can question the group about the number of employees in the group household and other details which can generate higher reported average incomes. Further work on income levels will be desirable during implementation, since the results between the social and focus group surveys are so different. At an average income of Đ64 million/year in 2016, affordability would be strong, with water accounting for less than 2% of income at the consumption and price levels budgeted.

Table B9 Project affordability analysis

		Income 2016	Increase in real income %/year	Income 2020	Income 2030
Focus group households	Đ'000	36200	5%	41906	61914
Average cost of water per HH	Đ'000			1479	1956
As % of HH income	%			3.5%	3.2%

Note: income is based on social survey, not on focus group discussions (which gave higher incomes)
Source: PPTA consultant

5. Economic Analysis

16. The following assumptions are used in the conversion and analysis:

- a. The assumed project life is 25 years including a one-year investment period;
- b. All items are in 2017 constant price;
- c. A general rate of value-added tax (VAT) is 10% in Vietnam; an additional 5% of tariffs is deducted from tradable components;
- d. The analysis is based on world price (US\$) numeraire, to be consistent with the analysis for the road subprojects;
- e. The exchange rate is VND22,350 to US\$1.00;
- f. A shadow wage factor (SWF) of 1.00 is applied to the salary of the water plant employees, who are mostly skilled or semi-skilled;
- g. A shadow wage factor (SWF) of 0.90 is applied to time value of beneficiary households;
- h. Further adjustment is required since the analysis uses world price (US\$) numeraire. A standard conversion factor (SCF) of 0.95 is applied to non-tradable components and labour;³
- i. The social cost of capital is taken to be 9.0%.

17. Economic internal rate of return under these assumptions is 9.2% (Table B10), slightly above the social project cut-off of 9%. It is possible that further analysis of willingness-to-pay would generate higher returns, but in practice any gains would be limited by the non-valuation of existing pipe or well supplies to the house which need valuation in a fully detailed assessment. Overall, it is believed that the increases in the economic value of water are a

³ The SCF of 0.95 was confirmed as current for Viet Nam by reference to the country profile of the World Trade Organization website.

reasonable reflection of overall willingness-to-pay, based on the affordability assessment and projected 5% per year increase in real incomes.

18. Sensitivity analysis was undertaken to assess the EIRR under different circumstances, including (i) investment cost overrun, (ii) operating costs overrun; (iv) reduction in project benefits; (v) reduction in new connections.

Table B10 Sensitivity Analysis

Sensitivity Test	FIRR (%)	ENPV (million US\$)	EIRR (%)	SI (%)	SV
Base Case	2.5%	43.4	9.2%		
+10% investment cost	2.0%	-137.4	8.3%	-1.190	-0.84
+10% operating costs	2.0%	-41.7	8.8%	-0.707	-1.4
-10% benefits	2.5%	-33.9	8.8%	-0.663	-1.5
-10% new connection	2.3%	-9.1	9.0%	-0.523	-1.9

FIRR = financial rate of return; ENPV = economic net present value; EIRR = economic internal rate of return; SI = sensitivity Index; SV = switching value

Source: PPTA consultant

Table B11: Economic Analysis

		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-42	2031
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12-24	Yr 13
Economic Benefits														
Economic value of water	VND mil		2,956	3,252	3,414	4,123	4,329	4,545	5,489	5,587	5,587	6,425	6,425	3,579
Health benefit	VND mil		173	190	200	210	220	231	243	247	247	247	247	273
Time Savings	VND mil		1,250	1,375	1,444	1,516	1,592	1,672	1,755	1,787	1,787	1,787	1,787	906
Total Economic Benefits	VND mil		2,482	2,606	2,736	3,160	3,286	3,385	3,850	3,966	4,085	4,665	4,758	4,758
Economic Costs														
Operating Costs														
Fixed costs														
Overheads	VND mil		187	191	195	199	203	207	211	211	211	211	211	187
Variable costs														
Electricity (36% of HG/m3)	VND mil		130	143	150	158	166	174	183	186	186	186	186	0
Chemicals (150% of HG/m3)	VND mil		649	714	749	787	826	868	911	927	927	927	927	0
Wages	VND mil		327	360	378	397	416	437	459	467	467	467	467	0
Oncosts	VND mil		123	136	142	149	157	165	173	176	176	176	176	0
Office costs	VND mil		0	0	0	0	0	0	0	0	0	0	0	0
Tools office/plant	VND mil		21	23	24	25	27	28	29	30	30	30	30	0
Repairs	VND mil		45	50	53	55	58	61	64	65	65	65	65	0
Other operating	VND mil		28	31	32	34	35	37	39	40	40	40	40	0
Total Operating Costs	VND mil		988	1,032	1,074	1,118	1,156	1,185	1,214	1,241	1,273	1,305	1,328	1,328
														0
Tax	VND mil													0
Total Operating Costs	VND mil		1,698	1,838	1,919	2,003	2,091	2,183	2,280	2,314	2,314	2,314	2,314	1,515
Net Economic Benefits	VND mil		2,681	2,979	3,140	3,846	4,050	4,265	5,206	5,308	5,308	6,146	6,146	6,146
	\$'000		120	133	140	172	181	191	233	237	237	275	275	275
Investment Costs														
Capital expenditure	\$'000	-2,011	0	0	0	0	0	0	0	0	0	0	0	0
Connection fee of new customers	\$'000	0	0	-14	-8	-8	-9	-9	-10	-4	0	0	0	0
Rehabilitation (2% every 5 years)	\$'000	0	0	0	0	0	-40	0	0	0	0	-40	0	0
Residual (40% in Yr 25)	\$'000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	805
Investing Cash Flow	\$'000	-2,011	0	-14	-8	-8	-49	-9	-10	-4	0	-40	0	0
Net Economic Resource Flow	\$'000	-2,011	120	119	133	164	132	182	223	234	237	235	275	275
ENPV	\$'000	43.38												
EIRR	%	9.23%												

Source: PPTA consultant

C. Hoang Su Phi District Water Plant, Ha Giang Province

1. Existing Situation

1. The subproject proposed for Vinh Quang town in Ha Giang province will replace the current city-based plant with a new water plant located at a higher elevation on the Pin Ho river upstream of Ban Nhung commune. It will supply the planned two communes and town by gravity, thus saving substantial pumping costs and eliminating the electricity supply problem of the current plant. It will also require less chemicals, since the input water is relatively clean.

2. The current plant, constructed in 2008, has significant problems relating to power shortage, high pumping costs and poor input water quality. The existing plant connects to around 836 metered connections (Table C1), but supplies more households through water sharing by some households. Revenue reflects 2016 performance, though without an allowance for charges for meter installation, since these represent a transfer of funds within the project boundary as well as a cost recovery exercise by the water company.

3. It is envisaged that the plant will only be used for emergency supplies (if at all) after the new plant is built, which will equate with the originally planned second phase. The existing water supply should be treated as non-incremental, with 700 m³/d peak capacity.

Table C1 Existing water plant performance

Connections	Number	Sales per connection est m ³ /d	Total daily sales m ³ /d	Annual sales m ³	Tariff Đ/m ³	Revenue Đ mil
Households	755	0.45	340	124.0	5800	719
Government	41	2.00	82	29.9	8700	260
Businesses	2	1.00	2	0.7	12000	9
Mixed business/HHs	38	0.80	30	11.1	8000	89
Connections/sales	836	0.54	454	165.8	7000	1077
People supplied	3204					

Source: PPTA consultant

2. Socio-economic Survey Results

4. A survey was undertaken in mid-2016 of 168 households in Vinh Quang town and two communes in Hoang Su Phi district which will be served by the new water supply. The socio-economic survey undertaken under BIIG generated a wide range of results that are relevant to gender and ethnic minorities. Many are also relevant to financial and economic assessment, summarized below analyzed by geographic location, rather than the ethnicity and gender classifications used in the main survey write-up.

Table C2 Household characteristics, health and time to collect water

	Unit	Town with water	Town without water	Commune	Total survey	%
Total Survey	no	36	52	80	168	
Female Headed Households	no	6	6	11	23	
Poverty						
Poor	%	3%	52%	54%		42%
Near poor	%	3%	12%	24%		15%
Non- poor	%	94%	37%	23%		42%
Total		100%	100%	100%		100%
Income per household						
Income from crops	Ð'000	475	3761	6703	4458	
Income from Livestock	Ð'000	28258	7601	7359	11913	
Other income	Ð'000	6151	1860	512	2138	
Total income	Ð'000	34884	13222	14575	18508	
Households with health problems in last year						
Having sore eyes	%	17%	12%	29%		21%
Diarrhea /dysentery	%	3%	2%	13%		7%
Skin disease	%	11%	2%	21%		13%
Responsible for fetching water						
Wife	%	11%	10%	15%		13%
Husband	%	6%	4%	29%		16%
Both husband and wife	%	3%	4%	13%		8%
Girls	%	0%	2%	0%		1%
Boys	%	0%	10%	5%		5%
Total	%	19%	29%	61%		42%
Travel time to water source						
In yard at house	no	32	42	63	137	82%
Less than 15 minutes	no	2	3	6	11	7%
From 15 to 30 minutes	no		3	3	6	4%
From 30 to 60 minutes	no			3	3	2%
Frequency of water collection						
Daily	no	1	8	16	25	15%
3 times a day	no	0	3	5	8	5%
every second day	no	0	0	1	1	1%
less than every second day	no	1	1	2	4	2%
Average travel time/trip each way	mins	7.5	15.0	20.6	17.6	
Average trips per day	no	0.6	1.4	1.3	1.3	
Average time per day for houses collecting water	mins	9.4	43.1	55.0	46.8	
Average time per household in total population	mins	0.6	5.4	8.8	6.0	
Houses with water to the yard %	%	89%	81%	79%		82%

Source: PPTA consultant

5. Main conclusions include:

- 42% of the survey sample were classed as “poor” with over 50% in the Town without water and Commune strata.
- Income per household averaged Ð18.5 million with Town with water having over double the other two classes. It is however, thought that household income was substantially under-reported.
- Health problems potentially related to water pollution included diarrhea (and very occasional dysentery) at 7% of households, sore eyes – 21% and skin disease 13%. It is of interest that the Town with water cohort reported higher disease rates than Town without.
- 87% of households reported that they had water to the yard (or house). The average time over the whole sample to collect water per day was 6 minutes. Based on more detailed estimation of time savings in Boc Bo, Bac Kan province, it was decided that the base case should include an estimate of time taken to collect water from the yard for those without elevated tanks or water piped to the house. An average of 6 minutes per household per day for those consumers was added, equal to 4 minutes over the total population.

Table C3 Attitudes to present and future water supply

	Unit	Town with water	Town without water	Commune survey	Total
Satisfaction with current water supply					
a) Does your current water supply/collection satisfy your daily need?	%	83%	73%	64%	71%
b) Is your water source reliable all year round in terms of quantity?	%	75%	54%	38%	51%
c) Does it take you longer to collect water or do you have to travel to a different location to collect water during dry season?	%	14%	31%	40%	32%
d) Is your water source reliable all year round in terms of quality?	%	36%	33%	39%	36%
e) Is your water source contaminated or in danger of being polluted?	%	39%	33%	40%	38%
g) Has water availability been decreasing over the years?	%	39%	33%	41%	38%
h) Do competing needs for water create conflicts in the community?	%	17%	6%	31%	20%
i) Is there a water management committee in this village?	%	50%	8%	6%	16%
j) If there is a water management committee do you participate?	%	14%	8%	15%	13%
k) Do you pay for water now?	%	100%	0%	4%	23%
l) Do you think that most people can pay for water?	%	86%	77%	68%	74%
m) Are you willing to pay for improved water from this project?	%	94%	83%	80%	84%
n) Do all socio-economic groups have equal access to water?	%	78%	62%	58%	63%
o) Do both women and men have equal access to water?	%	97%	87%	89%	90%
Expected benefits from improved water supply scheme					
a) Save time	%	31%	21%	16%	21%
b) Lessen work burden	%	25%	17%	14%	17%
c) Provide better cleaner environment for household generally	%	58%	46%	39%	45%
d) Less illness and disease for family	%	61%	37%	56%	51%
e) Will have enough water to satisfy family needs	%	25%	69%	74%	62%
Willingness to pay for water					
Do you pay for water now?	%	92%	0%	0%	20%
Do you think that most people can afford to pay for water?	%	86%	77%	68%	74%
Are you willing to pay for improved water?	%	92%	85%	80%	84%

Source: PPTA consultant

6. Points of interest from the table include:

- 71% of respondents reported that their access to water satisfied their needs. Surprising is that only 83% of Town with water respondents reported satisfaction.
- Only 38% of Commune respondents found that their supply was reliable year-round.
- 36% of the sample found that their water was of good quality, with surprisingly little difference between strata.
- 38% found that water availability has been declining.
- Only 63% believed that all socio-economic groups have equal access to water, presumably meaning that the poor and some ethnic groups find access more difficult.
- 21% of respondents believed that the new system would save time. Again it is unclear why 31% of Town with water respondents held this belief.
- 17% believed that the system would lessen their work burden, with 31% of Town with water and 16% of Commune respondents reporting.
- 51% thought that the system would lead to reduced disease incidence with little variation between strata, though again surprisingly Town with water was the highest.
- 74% thought that most people can afford to pay for water, while 84% are prepared to pay for water from the new plant.

3. Focus Group Discussion

7. Three focus groups were held in Hoang Su Phi district on 11 November 2016. Thanks are due to the Hoang Su Phi DPC for efficient organization of the groups.

Table C4 Summary of focus group outcomes, Hoang Su Phi district, Ha Giang

	Vinh Quang town	Tu Nhan commune	Ban Nhung commune
Number in FGD	9	9	9
Average adults/HH	2.6	2.2	2.9
Children	1.4	2.2	1.9
Family size	4.0	4.4	4.8

Water piped to house Network Own system Well	9 Stream - 2-7 HH/system 5 1	NA 2-3 HH/system 9	NA 2-3 HH/system 7 2 shared (4), 1 indiv Cost Đ6 mil in 2015 Likely but not recorded 100% 2-3 m ³ Đ500k
Rainwater Tanks	9 100% 2-3 m ³ brick	5 (those with tank) 60% 2-3 m ³ brick	Đ500k
Cost of water system Constructed Cost to repair	Đ4 mil 2013 Đ250k/y/system	Đ1.8 mil for pipe 2013 Đ500k/y/system	Đ175k/system
Water purchased WTP	37 m ³ /hh/mth		
Water demand m ³ /d Average income	2.5 m ³ /day Đ60 mil/HH/y	2 m ³ /day Đ42 mil/HH/y	>2m ³ /d Đ42 mil/HH/y
Expressed WTP Tariff Đ5k/m ³ Đ10k/m ³ Đ15k/m ³ Đ20k/m ³	100% 100% 90% 50%	100% 50% 30%	Buy 1m ³ Would not buy
WTP for connection Support pro-poor pricing	100%	Đ3 mil 100% 100%	Đ3 mil 100% Đ5 mil 0% 100%
Health Diarrhea Redeye Days lost total Cost	1 child 1 child 2 Đ350k	No health issues	All HH 1-2 or more 7 days, Aug/Sep adults 50% Đ10k medicine
Comments		Would renew stream systems even if connected to network. Probably buy 1 m ³ and take similar from stream. In dry season, collect water from other houses – 60L/hh/d	Supply is ok 12 mths Quality better dry season (Jan to Mar)

Source: PPTA consultant

8. Notable in the district is the high proportion of households that have permanent or semi-permanent connections. Only in Ban Nhung were people obliged to collect dry season water from neighbors who had access to a permanent stream. While the WTP questions were not detailed they indicate that:

- Town residents, being used to taking water from the network, have a high WTP, with a high stated volume purchased at present – far above the average for the town.
- If people in the communes were to purchase 30 m³/month the maximum they could pay to keep expenditure under 5% of income would be Đ5830/m³ or close to the current town tariff of Đ5700.
- All participants (i) supported pro-poor pricing, and (ii) were prepared to pay Đ3 million or more for a connection/meter if required.
- Participants indicated a high level of demand for water, with town participants indicating 2.5 m³ per day. In practice this is unlikely and lower levels of actual demand from the new WTP are estimated, increasing from 400 to 520 L/HH/day by 2030.

4. Financial Performance

9. The new plant has a design capacity of 2200 m³/day, allowing peak daily sales of about 1650 m³ net of in-plant use and network losses. Average daily sales at full development are estimated at 1214 m³, allowing for seasonal variations in demand. It is expected that this will be sufficient to meet demand in 2030, with a total of 2157 connections (Table C5)

Table C5 Estimated population by 2030

	Bản Nhũng commune	Tự Nhân commune	Vinh Quang town	Total
Number of households	206	77	1763	2046
Population	1107	415	6741	8263
Number of government agencies	5	6	50	61

Number of businesses	0	0	50	50
Total customers	211	83	1863	2157

Source: HG WS Field Report-EN-revised.docx para 7

10. Average tariff in 2020 is estimated at Đ8050 expressed in 2016 prices. Real price increases thereafter will be required to ensure the profitability of the plant and its ability to meet its debt service requirements. Real price rises of 15% are budgeted every three years, it will be necessary to achieve approximately this rate of increase over time, or alternatively for the PPC to agree to subsidize the plant. The scheduled tariff increases are also applied to the without project situation, which continues use of the existing plant at its current level until 2028.

11. Water sales per day by the new plant are expected to increase to 442,000 m³/year by 2030 – the full capacity of the plant. Water production costs are estimated based on the current Vinh Quang plant operating costs, adjusted for reduced electricity and chemical costs. The without project water provision estimate is limited to the existing plant supply to 2028. On these assumptions, the water plant would generate a financial internal rate of return of 2.9% over the 25-year assumed plant life.

12. It is also noted that water sales will be price dependent, and that care is needed to ensure that adequate water supplies are provided at an affordable price. Affordability is assessed in Table C6, which indicates that water consumption from the water plant at the level and cost indicated will not cost in excess of 5% of household income on average except in the communes based on survey data. If the survey data for the communes are accurate, a lower level of demand for network water there would be expected. Further work on income levels will be desirable during implementation, since the results between the social and focus group surveys are so different.

Table C6 Project affordability analysis

		Income 2016	Increase in real income %/year	Income 2020	Income 2030
Focus group commune	Đ'000	42000	5%	51051	83157
Focus group town	Đ'000	60000	5%	72930	118796
Survey HH commune	Đ'000	14200	5%	17260	28115
Survey HH town	Đ'000	30960	5%	37632	61299
Average cost of water per HH	Đ'000			1448	
As % of HH income					
Focus group commune	%			2.8%	3.0%
Focus group town	%			2.0%	2.1%
Survey HH commune	%			8.4%	9.0%
Survey HH town	%			3.8%	4.1%

Source: PPTA consultant

13. **Investment Cost.** Investment cost is estimated at VND52.0 billion (US\$2.32 million). Rehabilitation cost was estimated to be 2% every five years, based on discussion with Lang Son Water Supply company, which had provided estimated a lower figure.

Table C7 Water Plant Investment Cost

	Financial Cost		Decomposition		Economic Cost		
	VND mil	\$'000	Local (%)	Foreign (%)	Local \$'000	Foreign \$'000	Total \$'000
Construction costs							
Materials	26,364	1,180	80%	20%	896	236	1,132
Labor	7,581	339	100%	0%	322	0	322
Equipment	2,278	102	30%	70%	29	71	100
Subtotal	36,223	1,621			1,248	307	1,555
Equipment costs	532	24	30%	70%	7	17	23
Management costs	624	28	90%	10%	24	3	27
Consultancy	3,395	152	80%	20%	115	30	146
General costs and training	1,378	62	90%	10%	53	6	59
Contract Management	346	15	100%	0%	15	0	15

Peripheral electricity costs	182	8	90%	10%	7	1	8
Land compensation	307	14	100%	0%	13	0	13
Tax (10%)	4,722	211	100%	0%	0	0	0
Contingency cost	4,299	192	81%	19%	148	37	185
Total	52,006	2,327				401	2,030

Source: PPTA consultant

14. **Operating Cost.** The operating costs for the new plant are based on the existing Vinh Quang (Ha Giang) water plant's operating costs. The total overhead cost is VND 263.1 million. The variable unit cost of each input (Table C8, last column) are multiplied with water production to yield the total variable cost.

Table C8 Existing Vinh Quang Water Plant Operating Costs

	Amount (VND mil)	Composition		Overhead (VND mil)	Variable (VND mil)	Variable (VND/m3)
		Overhead (%)	Variable (%)			
Costs						
Electricity	307.6	0%	100%	0.0	307.6	2,129.6
Chemicals/materials	156.4	0%	100%	0.0	156.4	1,082.8
Wages	315.3	50%	50%	157.7	157.7	1,091.4
Oncosts	118.9	50%	50%	59.4	59.4	411.4
Office costs	33.8	100%	0%	33.8	0.0	0.0
Tools office/plant	22.2	55%	45%	12.2	10.0	69.7
Repairs	21.9	0%	100%	0.0	21.9	151.8
Other operating	13.4	0%	100%	0.0	13.4	92.5
Total operating costs	989.5			263.1	726.4	5,029
Tax	108.3	27%	73%	29.2	79.0	550.4

Source: PPTA consultant

15. The financial analysis of the Ha Giang subproject is based on an incremental analysis, by comparing the financial performance of the existing water utilities in the without- and with-project scenarios. The financial projections of the two scenarios are presented in Tables C9 and C10. The incremental analysis is presented in C11. The incremental FIRR is 2.1%.

Table C9 Financial Project – Without Project Scenario

	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-42	2043
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12-24	Yr 25
Revenue														2030-42
Tariff increase (real)	%		15%			15%			15%					
Average tariff	VND/m3		8,050	8,050	8,050	9,258	9,258	9,258	10,646	10,646	10,646	10,646	10,646	10,646
Average water sales per day														
Construction year (old plant)	'000 m3													
Revenue water available for sales per day	m3/day													
Revenue water available for sales per year	m3		166	166	166	166	166	166	166	166	166	166	166	166
Total Revenue	VND mil		1,334	1,334	1,334	1,535	1,535	1,535	1,765	1,765	1,765	1,765	1,765	1,765
Operating Costs														
Fixed costs														
Overheads	VND mil													
Variable costs														
Electricity (36% of HG/m3)	VND mil													
Chemicals (150% of HG/m3)	VND mil													
Wages	VND mil													
Oncosts	VND mil													
Office costs	VND mil													
Tools office/plant	VND mil													
Repairs	VND mil													
Other operating	VND mil													
Total Operating Costs	VND mil		1,145	1,145	1,145	1,145	1,145	1,145	1,145	1,145	1,145	1,145	1,145	0
Tax	VND mil													
Operating Cash Flow	VND mil	0	190	190	190	390	390	390	620	620	620	620	620	620
Investment Costs														
Capital expenditure	VND mil													
Rehabilitation (2% every 5 years)	VND mil													
Residual (40% in Yr 25)	VND mil													
Investing Cash Flow	VND mil													
Net Cash Flow	VND mil	0	190	190	190	390	390	390	620	620	620	620	620	620

Source: PPTA consultant

Table C10 Financial Project – With Project Scenario

	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-42	2043
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12-24	Yr 25
Revenue														
Tariff increase (real)	%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Average tariff	VND/m3		8,050	8,050	8,050	9,258	9,258	9,258	10,646	10,646	10,646	12,243	12,243	12,243
Average water sales per day														
Construction year (old plant)	'000 m3		0	0	0	0	0	0	0	0	0	0	0	0
Revenue water available for sales per day	m3/day		424	834	864	896	930	965	1003	1044	1087	1133	1182	1211
Revenue water available for sales per year	m3		154578	304430	315392	326990	339280	352322	366187	380948	396689	413504	431494	441991
Total Revenue	VND mil		1,244	2,451	2,539	3,027	3,141	3,262	3,898	4,056	4,223	5,063	5,283	5,411
Operating Costs														
Fixed costs														
Overheads	VND mil		197	201	205	209	214	218	222	222	222	222	222	0
Variable costs														
Electricity (36% of HG/m3)	VND mil		33	65	67	70	72	75	78	81	84	88	92	0
Chemicals (150% of HG/m3)	VND mil		117	231	239	248	257	267	278	289	301	313	327	0
Wages	VND mil		169	332	344	357	370	385	400	416	433	451	471	0
Oncosts	VND mil		64	125	130	135	140	145	151	157	163	170	178	0
Office costs	VND mil		0	0	0	0	0	0	0	0	0	0	0	0
Tools office/plant	VND mil		11	21	22	23	24	25	26	27	28	29	30	0
Repairs	VND mil		23	46	48	50	52	53	56	58	60	63	66	0
Other operating	VND mil		14	28	29	30	31	33	34	35	37	38	40	0
Total Operating Costs	VND mil		628	1,050	1,085	1,121	1,159	1,200	1,243	1,284	1,328	1,375	1,425	0
Tax	VND mil		85	168	174	180	187	194	202	210	218	228	237	0
Operating Cash Flow	VND mil	0	531	1,233	1,281	1,726	1,795	1,868	2,454	2,562	2,677	3,460	3,620	5,411
Investment Costs														
Capital expenditure	VND mil	-52006	0	0	0	0	0	0	0	0	0	0	0	0
Rehabilitation (2% every 5 years)	VND mil	0	0	0	0	0	0	0	0	0	0	0	0	0
Residual (40% in Yr 25)	VND mil	0	0	0	0	0	-1040	0	0	0	0	-1040	0	0
Investing Cash Flow	VND mil	-52,006	0	0	0	0	-1,040	0	0	0	0	-1,040	0	0
Net Cash Flow	VND mil	-52,006	531	1,233	1,281	1,726	755	1,868	2,454	2,562	2,677	2,420	3,620	5,411

Source: PPTA consultant

Table C11 Financial Analysis

	Unit	2019 Yr 1	2020 Yr 2	2021 Yr 3	2022 Yr 4	2023 Yr 5	2024 Yr 6	2025 Yr 7	2026 Yr 8	2027 Yr 9	2028 Yr 10	2029 Yr 11	2030-42 Yr 12-24	2043 Yr 25
Revenue														
Tariff increase (real)	%													
Average tariff	VND/m3	0	0	0	0	0	0	0	0	0	0	1,597	1,597	1,597
Average water sales per day														
Construction year (old plant)	'000 m3	0	0	0	0	0	0	0	0	0	0	0	0	0
Revenue water available for sales per day	m3/day	0	424	834	864	896	930	965	1,003	1,044	1,087	1,133	1,182	1,211
Revenue water available for sales per year	m3	0	154,412	304,264	315,227	326,825	339,114	352,157	366,021	380,782	396,524	413,338	431,329	441,825
Total Revenue	VND mil	0	-90	1,116	1,205	1,493	1,606	1,727	2,134	2,291	2,458	3,298	3,518	3,647
Operating Costs														
Fixed costs														
Overheads	VND mil	0	197	201	205	209	214	218	222	222	222	222	222	0
Variable costs														
Electricity (36% of HG/m3)	VND mil	0	33	65	67	70	72	75	78	81	84	88	92	0
Chemicals (150% of HG/m3)	VND mil	0	117	231	239	248	257	267	278	289	301	313	327	0
Wages	VND mil	0	169	332	344	357	370	385	400	416	433	451	471	0
Oncosts	VND mil	0	64	125	130	135	140	145	151	157	163	170	178	0
Office costs	VND mil	0	0	0	0	0	0	0	0	0	0	0	0	0
Tools office/plant	VND mil	0	11	21	22	23	24	25	26	27	28	29	30	0
Repairs	VND mil	0	23	46	48	50	52	53	56	58	60	63	66	0
Other operating	VND mil	0	14	28	29	30	31	33	34	35	37	38	40	0
Total Operating Costs	VND mil	0	-516	-95	-60	-24	15	55	98	139	183	230	280	0
Tax	VND mil	0	85	168	174	180	187	194	202	210	218	228	237	0
Operating Cash Flow	VND mil	0	341	1,043	1,091	1,336	1,405	1,478	1,834	1,942	2,057	2,840	3,000	4,791
Investment Costs														
Capital expenditure	VND mil	-52006	0	0	0	0	0	0	0	0	0	0	0	0
Rehabilitation (2% every 5 years)	VND mil	0	0	0	0	0	0	0	0	0	0	0	0	0
Residual (40% in Yr 25)	VND mil	0	0	0	0	0	-1040	0	0	0	0	-1040	0	0
Investing Cash Flow	VND mil	-52,006	0	0	0	0	-1,040	0	0	0	0	-1,040	0	0
Net Cash Flow	VND mil	-52,006	341	1,043	1,091	1,336	365	1,478	1,834	1,942	2,057	1,800	3,000	4,791
FIRR	%	2.1%												

Source: PPTA consultant

5. Economic Analysis

16. The main adjustments made to calculate economic return are:

The following assumptions are used in the conversion and analysis:

- a. The assumed project life is 25 years including a one-year investment period;
- b. All items are in 2017 constant price;
- c. A general rate of value-added tax (VAT) is 10% in Vietnam; an additional 5% of tariffs is deducted from tradable components;
- d. The analysis is based on world price (US\$) numeraire, to be consistent with the analysis for the road subprojects;
- e. The exchange rate is VND22,350 to US\$1.00;
- f. A shadow wage factor (SWF) of 1.00 is applied to the salary of the water plant employees, who are mostly skilled or semi-skilled;
- g. A shadow wage factor (SWF) of 0.90 is applied to time value of beneficiary households;
- h. Further adjustment is required since the analysis uses world price (US\$) numeraire. A standard conversion factor (SCF) of 0.95 is applied to non-tradable components and labour;⁴
- i. The social cost of capital is taken to be 9.0%.

17. Economic internal rate of return under these assumptions is 9.4%. It is possible that further analysis of willingness-to-pay would generate higher returns, but in practice any gains would be limited by the non-valuation of existing pipe or well supplies to the house which would need valuation in a fully detailed assessment.

18. Sensitivity analysis was undertaken to assess the EIRR under different circumstances, including (i) investment cost overrun, (ii) operating costs overrun; (iv) reduction in project benefits; (v) reduction in new connections.

Table C12 Sensitivity Analysis

Sensitivity Test	FIRR (%)	ENPV (million US\$)	EIRR (%)	SI (%)	SV
Base Case	2.1%	82.2	9.4%		
+10% investment cost	1.6%	-100.3	8.5%	-1.001	-1.0
+10% operating costs	1.8%	27.6	9.1%	-0.312	-3.2
-10% benefits	2.1%	19.0	9.1%	-0.361	-2.8
-10% new connection	2.1%	29.1	9.2%	-0.302	-3.3

FIRR = financial rate of return; ENPV = economic net present value; EIRR = economic internal rate of return; SI = sensitivity Index; SV = switching value

Source: PPTA consultant

⁴ The SCF of 0.95 was confirmed as current for Viet Nam by reference to the country profile of the World Trade Organization website.

Table C13 Economic Analysis

		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-42	2043
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12-24	Yr 25
Economic Benefits														
Economic value of water	VND mil		2,771	3,048	3,200	3,865	4,058	4,261	5,145	5,237	5,237	6,023	6,023	3,579
Health benefit	VND mil		208	214	219	225	231	237	244	250	256	262	267	273
Time Savings	VND mil		1,078	1,108	1,136	1,166	1,197	1,229	1,263	1,295	1,327	1,361	1,383	906
Total Economic Benefits	VND mil		2,482	2,606	2,736	3,160	3,286	3,385	3,850	3,966	4,085	4,665	4,758	4,758
Economic Costs														
Operating Costs														
Fixed costs														
Overheads	VND mil		187	191	195	199	203	207	211	211	211	211	211	187
Variable costs														
Electricity (36% of HG/m3)	VND mil		38	74	77	79	82	86	89	92	96	100	105	0
Chemicals (150% of HG/m3)	VND mil		111	219	227	235	244	254	264	274	286	298	311	0
Wages	VND mil		160	316	327	339	352	365	380	395	411	429	447	0
Oncosts	VND mil		60	119	123	128	133	138	143	149	155	162	169	0
Office costs	VND mil		0	0	0	0	0	0	0	0	0	0	0	0
Tools office/plant	VND mil		10	20	21	22	22	23	24	25	26	27	29	0
Repairs	VND mil		22	44	45	47	49	51	53	55	57	60	62	0
Other operating	VND mil		14	27	28	29	30	31	32	33	35	36	38	0
Total Operating Costs	VND mil		988	1,032	1,074	1,118	1,156	1,185	1,214	1,241	1,273	1,305	1,328	1,328
Tax	VND mil													0
Total Operating Costs	VND mil		791	1,201	1,238	1,277	1,318	1,361	1,407	1,446	1,489	1,534	1,582	1,515
Net Economic Benefits	VND mil		3,266	3,169	3,318	3,978	4,167	4,366	5,245	5,336	5,332	6,112	6,090	6,090
	\$'000		146	142	148	178	186	195	235	239	239	273	273	273
Investment Costs														
Capital expenditure	\$'000	-2,030	0	0	0	0	0	0	0	0	0	0	0	0
Connection fee of new customers	\$'000	0	0	-4	-4	-4	-4	-4	-4	-4	-4	-4	-3	0
Rehabilitation (2% every 5 years)	\$'000	0	0	0	0	0	-41	0	0	0	0	-41	0	0
Residual (40% in Yr 25)	\$'000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	812
Investing Cash Flow	\$'000	-2,030	0	-4	-4	-4	-45	-4	-4	-4	-4	-45	-3	0
Net Economic Resource Flow	\$'000	-2,030	146	138	145	174	142	191	230	235	235	229	270	273
ENPV	\$'000	82.22												
EIRR	%	9.44%												

Source: PPTA consultant

