5.2 Construction and Implementation Plan

5.2.1 Project Cost

The construction cost is estimated based on the design criteria and results of preliminary design. The costs include procurement cost for materials and cost of construction works. However, the cost for house connection does not include installation cost and it includes only cost that would be required to supply water meters and connecting pipe within 10m length each household. It is considered that the installation cost of house connections shall be borne by consumers.

As a result of the discussion with Binh Thuan P-CERWASS, it is observed that water service of system FBG-13 covers very large area, and additional office shall be required for component 7 in Table 5.2.1, working under the main office, in order to carry out administrative works such as water charge collection in the faraway area. Procedures of the estimation are explained below.

(1) Civil and Architecture

The cost for civil and architectural components was calculated using the volume of works for each facility and unit cost. The water tanks volume and floor area of the buildings were calculated based on the preliminary design drawings. Unit costs for each case normally expressed per m^3 and per m^2, has been determined based on the past experience of ODA project.

(2) Pipeline

The total length of the pipeline was estimated based on the general arrangement in drawings of the preliminary design. The diameter of the pipe was calculated through the hydrostatic calculation for pipe network. The unit cost of pipe was determined considering the past experience of ODA project.

(3) Pump and Motor

The cost of pumps and motors was adopted considering the lowest price in estimates carried out by the Japanese companies. The cost for small capacity and general pumps was adopted considering Vietnamese and Japanese market conditions.

(4) Treatment Plant

Considering cost of the projects undertaken in past, the cost per m^3 of the treatment capacity is estimated and plotted as shown in Figure 5.2.1. This cost includes mechanical, electrical, building and civil works of the treatment plant in the past record of ODA project. The civil cost is estimated based on tank volume and unit cost. Building cost is estimated based on floor space and unit cost. The cost of mechanical and electrical components is calculated by reducing cost of civil works from total cost. The mechanical and electrical cost for system FKS-6 and 8 were adopted considering the lowest price by Maker. According to the cost evaluation, the mechanical and electrical cost contributes about less than 35% of the total cost. It is considered reasonable and propriety.

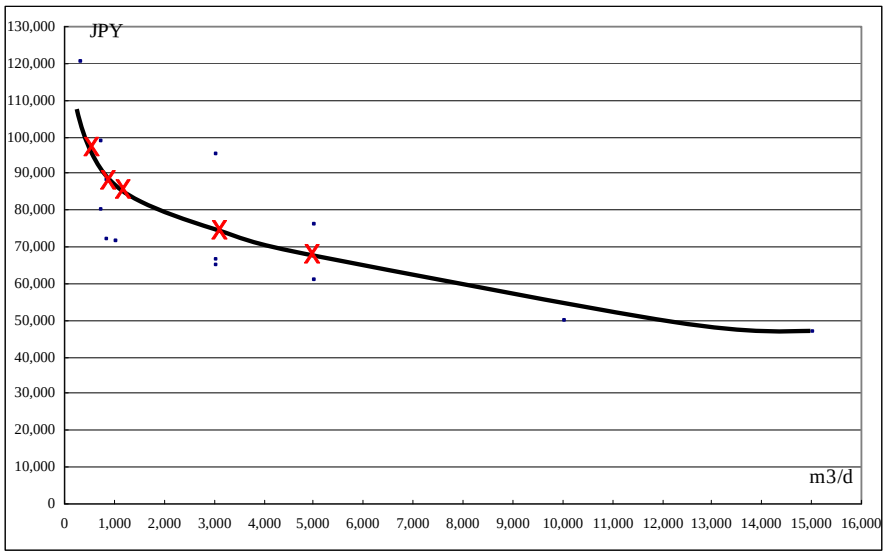

Figure 5.2.1 Construction Cost per m^3

For more detail on the cost estimation, please refer to Supporting report. The construction cost is summarized in Table 5.2.1.

Table 5.2.1 Construction Cost

Component	Cost (US$)									Total
	FPS2	FPS3	FPG4	FPS5	FKS6	FKS8	FNG10	FBS11	FBG13	
1 Intake facility	30,500	115,100	209,200	45,600	47,600	82,200	200,000	54,800	338,000	1,123,000
2 Transmission pipe line	180,000	41,600	531,000	62,500	14,800	374,400	2,948,500	274,600	1,062,100	5,489,500
3 Water treatment plant	654,800	0	899,900	0	379,800	442,000	2,048,600	663,100	3,229,000	8,317,200
4 Distribution facility	480,000	618,800	1,355,600	497,200	318,600	440,000	1,985,600	319,800	3,667,500	9,683,100
5 Distribution pump station	0	0	35,200	0	0	0	106,300	0	99,000	240,500
6 House connection materials	52,700	99,300	88,800	64,900	38,200	42,000	160,100	51,200	327,300	924,500
7 Staff building	0	0	0	0	0	0	0	0	131,900	131,900
Total	1,398,000	874,800	3,119,700	670,200	799,000	1,380,600	7,449,100	1,363,500	8,854,800	25,909,700
Million VND	23,559	14,742	52,573	11,294	13,465	23,266	125,532	22,978	149,221	436,630

Based on the construction cost, the total project cost is estimated to be about 37.33million US Dollar and it is equivalent to 629 million Vietnamese Dong as given in Table 5.2.2.
The project cost is estimated based on the conditions and assumptions explained below.

(A) Construction Cost

The cost under this head comprises direct cost required for construction of the facilities and infrastructures including materials and constructions.

(B) Engineering Services

This cost includes expenditure on site survey, design, supervision during construction stage, and

assistance provided during tender stage by the consultants. The cost is considered as 10% of construction cost (A).

(C) Cost to be borne by Vietnam

This cost includes costs on land acquisition and clearing, fencing of the facilities, establishment of primary electric power line and access road to the facilities. These costs are estimated based on past experience and data of Japanese grant aid projects and the cost is borne by recipient country in general.

(D) Base Cost

This cost is the total of costs in items (A), (B) and (C).

(E) Contingency

This cost is 10% of (D) base cost.

(F) VAT (Value Added Tax)

The tax is calculated as 10% of total in items (A) and (B).

(G) Project Cost

The project cost is calculated as total of items (D), (E) and (F).

Table 5.2.2 Project Cost Summary

Currency :US$

System	(A) Construction Cost	(B) Engineering Cost	(C) Cost to be borne by Vietnam	(D) Base Cost	(E) Contingency	(F) VAT	(G) Project Cost
FPS2	1,398,000	139,800	153,800	1,691,600	169,200	153,800	2,014,600
FPS3	874,800	87,500	96,300	1,058,600	105,900	96,200	1,260,700
FPG4	3,119,700	312,000	343,100	3,774,800	377,500	343,200	4,495,500
FPS5	670,200	67,000	73,700	810,900	81,100	73,700	965,700
Sub total	6,062,700	606,300	666,900	7,335,900	733,700	666,900	8,736,500
FKS6	799,000	79,900	87,800	966,700	96,700	87,900	1,151,300
FKS8	1,380,600	138,100	151,900	1,670,600	167,000	151,900	1,989,500
Sub total	2,179,600	218,000	239,700	2,637,300	263,700	239,800	3,140,800
FNG10	7,449,100	744,900	819,400	9,013,400	901,300	819,400	10,734,100
Sub total	7,449,100	744,900	819,400	9,013,400	901,300	819,400	10,734,100
FBS11	1,363,500	136,400	150,000	1,649,900	165,000	150,000	1,964,900
FBG13	8,854,800	885,500	974,100	10,714,400	1,071,400	974,000	12,759,800
Sub total	10,218,300	1,021,900	1,124,100	12,364,300	1,236,400	1,124,000	14,724,700
Total (US$)	25,909,700	2,591,100	2,850,100	31,350,900	3,135,100	2,850,100	37,336,100
Total (VND)	436,630	43,665	48,030	528,325	52,833	48,030	629,188

(Exchange rate: 1US$:VND16, 852: JY 106.17 (July 2008)

5.2.2 O&M Cost

O&M cost by water supply system is estimated, which includes costs of personnel, chemical, electrical, repair and others. As a result, O&M cost per unit water consumption is estimated to be 2,307 VND/m^3 in average. The calculation result is presented in Table 5.2.3.

Table 5.2.3 Tentative Cost Estimation of O&M for Water Supply System

	[A] Annual Production (m^3/year)	[B] Annual Consumption (m^3/year)	Operation and Maintenance Cost (x1000 VND/year)						[I] O&M cost per unit water consumption (VND/m^3)
			[C] Staff	[D] Chemical	[E] Electrical	[F] Repair	[G] Others	[H] Total	
FPS-2	183,000	165,000	129,600 37.4%	54,168 15.6%	65,880 19.0%	65,109 18.8%	31,476 9.1%	346,233 100.0%	2,098
FPS-3	364,000	328,000	108,000 45.3%	2,184 0.9%	66,976 28.1%	39,657 16.6%	21,682 9.1%	238,499 100.0%	727
FPG-4	332,000	299,000	129,600 13.2%	97,940 10.0%	517,256 52.6%	149,940 15.2%	89,474 9.1%	984,210 100.0%	3,292
FPS-5	238,000	214,000	108,000 50.5%	1,428 0.7%	60,452 28.3%	24,501 11.5%	19,438 9.1%	213,819 100.0%	999
FKS-6	173,000	156,000	129,600 46.5%	1,038 0.4%	67,470 24.2%	55,275 19.8%	25,338 9.1%	278,721 100.0%	1,787
FKS-8	192,000	173,000	129,600 32.1%	40,896 10.1%	128,640 31.9%	67,566 16.8%	36,670 9.1%	403,372 100.0%	2,332
FNG-10	784,000	706,000	302,400 12.8%	230,496 9.7%	1,278,704 53.9%	343,194 14.5%	215,479 9.1%	2,370,273 100.0%	3,357
FBS-11	203,000	183,000	129,600 34.1%	60,088 15.8%	98,049 25.8%	57,756 15.2%	34,549 9.1%	380,042 100.0%	2,077
FBG-13	1,361,000	1,225,000	561,600 20.5%	400,134 14.6%	1,109,215 40.5%	420,765 15.4%	249,171 9.1%	2,740,885 100.0%	2,237
Total	3,830,000	3,449,000	1,728,000 21.7%	888,372 11.2%	3,392,642 42.6%	1,223,763 15.4%	723,277 9.1%	7,956,054 100.0%	2,307

Remarks:

[A]= [Maximum Daily Production (from Table A1)] / 1.2(Maximum daily factor) x 365 days
[B]= [A] x 90% (Loss: 10%)
[C]= [Personnel expense (from Table C1)]
[D]= [A] x [Chemical cost (from Table D1)]
[E]= [A] x [Electric power cost (from Table E1)]
[F]= [Construction cost (from Table F1)] x 0.3%
[G]= ([C]+[D]+[E]+[F]) x 10%
[H]= [C]+[D]+[E]+[F]+[G]
[I]= [H] / [B]

Table A1 Maximum Daily Production

FPS-2	**603** m3/day
FPS-3	**1,198** m3/day
FPG-4	**1,091** m3/day
FPS-5	**781** m3/day
FKS-6	**569** m3/day
FKS-8	**631** m3/day
FNG-10	**2,578** m3/day
FBS-11	**667** m3/day
FBG-13	**4,474** m3/day

Table C1 Personnel Expenses

	[C1.1] Population Served (persons)	[C1.2] Staff Numbers (persons)	[C1.3] Monthly Salary (x1000 VND/month)	[C1.4] Annual Expense (x1000 VND/annum)
FPS-2	6,856	6	1,800	**129,600**
FPS-3	13,256	5	1,800	**108,000**
FPG-4	11,655	6	1,800	**129,600**
FPS-5	9,292	5	1,800	**108,000**
FKS-6	6,684	6	1,800	**129,600**
FKS-8	6,978	6	1,800	**129,600**
FNG-10	29,715	14	1,800	**302,400**
FBS-11	7,378	6	1,800	**129,600**
FBG-13	52,241	26	1,800	**561,600**

(Notes)

[C1.2]= [C1.1] / 2000, minimum 5 for groundwater source and minimum 6 for surface water source
On assumption that staff efficiency in 2020 would be 2000 persons per staff.

[C1.3]= Average salary of VND 1,800,000 per month is assumed for calculation purpose.

[C1.4]= [C1.2] x [C1.3] x 12 months

Table D1 Chemical Cost per unit Water Production

	[D1.1] Maximum daily production (m3/day)	[D1.2] Chemical cost per day (VND/day)	[D1.3] Chemical cost per production (VND/m3)
FPS-2	603	178,488	**296**
FPS-3	1,198	7,200	**6**
FPG-4	1,091	322,356	**295**
FPS-5	781	4,740	**6**
FKS-6	569	3,600	**6**
FKS-8	631	134,286	**213**
FNG-10	2,578	756,708	**294**
FBS-11	667	197,142	**296**
FBG-13	4,474	1,313,574	**294**

(Notes)

[D1.2]= [Chamical cost per day (VND/day) as per Table D2]

[D1.3]= [D1.2] / [D1.1]

Table D2 Calculation on Chemical Cost per day (Maximum Daily Base)

	Chemical Dosing Equipment	[D2.1] Maximum Daily Water Flow (m3/day)	[D2.2] Dosing Rate (mg/L)	[D2.3] Dosage (kg/day)	[D2.4] Unit Cost (VND/kg)	[D2.5] Amount (VND/day)
FPS-2	Coagulant	670	17.0	11.4	15,000	170,850
	Pre-chlorination	670	1.0	0.7	6,000	4,020
	Post-chlorination	603	1.0	0.6	6,000	3,618
					Total	178,488
FPS-3	Post-chlorination	1,200	1.0	1.2	6,000	7,200
					Total	7,200
FPG-4	Coagulant	1,210	17.0	20.6	15,000	308,550
	Pre-chlorination	1,210	1.0	1.2	6,000	7,260
	Post-chlorination	1,091	1.0	1.1	6,000	6,546
					Total	322,356
FPS-5	Post-chlorination	790	1.0	0.8	6,000	4,740
					Total	4,740
FKS-6	Post-chlorination	600	1.0	0.6	6,000	3,600
					Total	3,600
FKS-8	Coagulant	500	17.0	8.5	15,000	127,500
	Pre-chlorination	500	1.0	0.5	6,000	3,000
	Post-chlorination	631	1.0	0.6	6,000	3,786
					Total	134,286
FNW-12	Coagulant	2,840	17.0	48.3	15,000	724,200
	Pre-chlorination	2,840	1.0	2.8	6,000	17,040
	Post-chlorination	2,578	1.0	2.6	6,000	15,468
					Total	756,708
FBS-11	Coagulant	740	17.0	12.6	15,000	188,700
	Pre-chlorination	740	1.0	0.7	6,000	4,440
	Post-chlorination	667	1.0	0.7	6,000	4,002
					Total	197,142
FBG-13	Coagulant	4,930	17.0	83.8	15,000	1,257,150
	Pre-chlorination	4,930	1.0	4.9	6,000	29,580
	Post-chlorination	4,474	1.0	4.5	6,000	26,844
					Total	1,313,574

(Notes)

Coagulant: PAC (polyaluminium chloride) is tentatively employed for calculation purpose.
Although alum and soda ash are also used in existing plant operation,
cost for these chemicals are the same level with the case of PAC.

Chlorination: Pre-/Post-Chlorination is tentatively employed for surface water treatment systems.
Post-Chlorination is employed for groundwater system.

[D2.1]: [Maximum daily intake]
#) For system FKS-8, 70% of total intake flow is assumed as surface water intake.

[D2.2]: Average dosing rates of existing plants are employed for calculation purpose.

[D2.3]: [D2.1] x [D2.2]

[D2.4]: Units costs are assumed from existing data.

[D2.5]: [D2.3] x [D2.4]

Table E1 Electrical Power Cost per unit Production

	[E1.1] Maximum daily production (m3/day)	[E1.2] Power consumption per day (kWh/day)	[E1.3] Unit cost (VND/kWh)	[E1.4] Electric power cost per day (VND/day)	[E1.5] Electric power cost per (VND/m3)
FPS-2	603	217	1,000	217,000	**360**
FPS-3	1,198	220	1,000	220,000	**184**
FPG-4	1,091	1,700	1,000	1,700,000	**1,558**
FPS-5	781	198	1,000	198,000	**254**
FKS-6	569	222	1,000	222,000	**390**
FKS-8	631	423	1,000	423,000	**670**
FNG-10	2,578	4,206	1,000	4,206,000	**1,631**
FBS-11	667	322	1,000	322,000	**483**
FBG-13	4,474	3,646	1,000	3,646,000	**815**

(Notes)
[E1.2]= [Electrical power consumption per day (kWh/day) as per Table E2]
[E1.3]= 1000 VND/kWh is assumed based on current tariff (985 VND/kWh, May 2008)
[E1.4]= [E1.2] x [E1.3]
[E1.5]= [E1.4] / [E1.1]

Table E2 Calculation on Electrical Power Cost per day (Maximum Daily Base)

	Type of Pump	[E2.1] Motor output rate per unit (kW)	[E2.2] Number of operating units (units)	[E2.3] Total output rate (kW)	[E2.4] Operation hours (h)	[E2.5] Power consumption (kWh)
FPS-2	Intake pump	1.5	2	3.0	20	60
	Transmission pump	3.7	2	7.4	20	148
	Others(15% of intake)					9
					Total	217
FPS-3	Intake Pump	5.5	2	11.0	20	220
					Total	220
FPG-4	Intake Pump	15.0	2	30.0	20	600
	Distribution pump-1	15.0	2	30.0	10	300
	Transmission pump	15.0	2	30.0	20	600
	Distribution pump-2	5.5	2	11.0	10	110
	Others(15% of intake)					90
					Total	1,700
FPS-5	Intake Pum	2.2	2	4.4	20	88
	Distribution pump	5.5	2	11.0	10	110
					Total	198
FKS-6	Intake Pump	3.7	3	11.1	20	222
					Total	222
FKS-8	Intake Pump (Groundwater)	2.2	2	4.4	20	88
	Intake pump (River)	0.75	2	1.5	20	30
	Transmission pump	7.5	2	15.0	20	300
	Others(15% of intake (river))					5
					Total	423
FNG-10	Intake Pump	11.0	2	22.0	20	440
	Transmission pump	37.0	3	111.0	20	2,220
	Booster pump	37.0	2	74.0	20	1,480
	Others(15% of intake)					66
					Total	4,206
FBS-11	Intake Pump	1.5	2	3.0	20	60
	Distribution pump	11.0	2	22.0	10	220
	Others(15% of intake)					42
					Total	322
FBG-13	Intake Pump	15.0	2	30.0	20	600
	Transmission pumps	55.0	2	110.0	20	2,200
	Distribution pumps	18.5	2	37.0	10	370
	Others(15% of intake)					476
					Total	3,646

(Notes)
[E2.3]: [E2.1] x [E2.2]
[E2.4]: 20 hours for operation (inttake pumps, water treatment equipment, transmission pumps)
Operation hours for distribution pumps are calculated by 20 hours / hourly peak factors (2.0)
[E2.5]: [E2.3] x [E2.4]
Others (15%): To include other electrical loads for sludge treatment system, filter washing system, etc.

Table F1 Construction Cost

	million VND
FPS-2	**23,559**
FPS-3	**14,742**
FPG-4	**52,573**
FPS-5	**11,294**
FKS-6	**13,465**
FKS-8	**23,266**
FNG-10	**125,532**
FBS-11	**22,977**
FBG-13	**149,221**

5.2.3 Implementation Plan

(1) Priority Order for the Construction Schedule

Bases on the schedule presented in Chapter 3.4 in Master Plan, 9 water supply systems considered in the FS are categorized under Packages 1 and 2. If the project implementation starts in year 2009, it is expected that the project shall be completed in year 2014. This is due to the consideration that implementation of these project activities shall require at least 6 years.

In order to arrange the progress of construction work in the project schedule, the priority of 9 systems is set based on the results of selection of Priority project described in Chapter 3.5 of Master Plan. The priority order is separated by every province in order to have uniformity in development of project effectiveness. The priority order is shown in Table 5.2.4.

Table 5.2.4 Priority Order

Province	System	Total score	Ranking	Main water source
Phu yen	FPS-5	42	1	Groundwater
	FPS-3	41	2	Groundwater
	FPG-4	48	3	Surface water
	FPS-2	47	4	Surface water
Khan Hoa	FKS-6	32	1	Groundwater
	FKS-8	45	2	Groundwater
Ninh Thuan	FNG-10	40	1	Surface water
Binh Thuan	FBG-13	47	1	Surface water
	FBS-11	46	2	Surface water

Groundwater and surface water is evaluated based on the different standard and items. In technical condition, maximum score for groundwater is 15 and surface water source is 25 points. 3 systems, FPS-3, -5 and FKS-6, using groundwater sources are scored top ranking in addition to the system using surface water sources. System FKS-8 has also been places as top priority. Although the system is designed using combination of groundwater and surface water sources, the groundwater is main water source contributing 60% of the total requirement.

(2) Project Implementation Schedule

The implementation schedule is split up into 3 stages extending through 6 years and these stages are named as financial preparation, detailed design and construction stage. Under each stage, following works are included.

1) Stage A: Financial Preparation

This stage includes activities of justification of the project, approval of the project by the Government, the technical supplementary surveys, financial arrangement and preparation of the project site such as land acquisition, approval of water source.

In order to reduce the error to less than plus, minus 10% of construction cost, the supplementary surveys shall be carried out comprising following main items.

- Confirmation of sitting of the well,
- Confirmation of geographical conditions such as longitudinal and plane survey of intake area including river (S:1/200), longitudinal survey along pipeline route (H:1/1000, V:1/200) and Survey for planned area for each equipments (S: 1/200),
- Confirmation of construction conditions such as crossing points and construction method for road, railway and river crossing,
- Water quality tests such as J-test and breaking-point test,
- Soil exploration at intake facility and water treatment plant,
- Marketing research for materials and equipments in Vietnam.

2) Stage B: Detailed Design

The stage shall include following main activities.

- Preparation of tender documents,

3) Stage C: Construction

The following main activities shall be undertaken in this Stage of Project.

- Tendering and tenderer negotiation.
- Finalize contract
- Temporary works
- Construction and supervision
- Capacity development
- Test run and hand over

The implementation schedule of the project is shown in Figure 5.2.2.

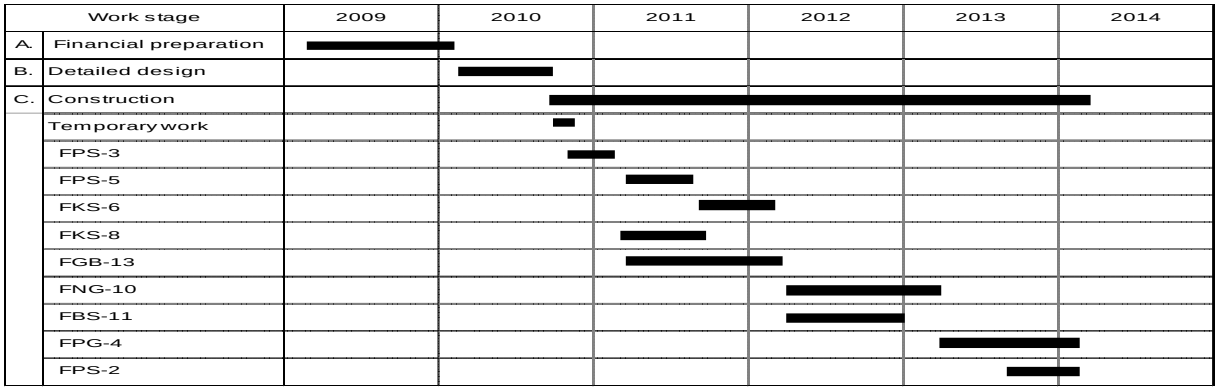

Figure 5.2.2 Project Schedule

(3) Disbursement Schedule

Based on the project schedule, the cost excluding price escalation will be disbursed in the manner presented in Table 5.2.5. Project cost, consisting of cost for facilities construction, engineering services, etc. is estimated in Table 5.2.2. The cost is estimated considering the price level of year 2008.

Table 5.2.5 Disbursement Schedule

Unit: x$1000

Stage		2009	2010	2011	2012	2013	2014	Total
A.	Financial preparation	2,850						2,850
B.	Detailed design		330					330
C.	Construction							
	Supervisor (engineering fee)		61	600	600	600	400	2,261
	Temporary works		1595					1,595
	System FPS-3		1,023					1,023
	System FPS-5			784				784
	System FKS-6			594	340			934
	System FKS-8			1,615				1,615
	System FBG-13			10,355				10,355
	System FNG-10				8,711			8,711
	System FBS-11				1,595			1,595
	System FPG-4					3,388	260	3,648
	System FPS-2					1,501	134	1,635
Total cost in 1000US$		2,850	3,009	13,948	11,246	5,489	794	37,336
(Million Vietnam Dong)		48,029	50,708	235,052	189,515	92,500	13,384	629,188

(Exchange rate: 1US$:VND16, 852: JY 106.17 (July 2008)

5.3 Evaluation of Priority Project

5.3.1 Financial and Economic Analysis

(1) Financial Analysis

The financial analysis of the project was carried out in the targeted nine systems by means of the financial internal rate of return (FIRR) and net present value (NPV) methods. The calculation of the FIRR and NPV are based on the projected income and expenditure statement indicated in Table 5.3.3. Assumptions used for the statement and calculation method of FIRR and NPV are given below.

1) Projected Income and Expenditure Assumption

a. Income

- The four P-CERWASSs' incomes are, in principle, generated from two sources;
  - (i) Water charges from operation
  - (ii) Miscellaneous revenues from operations such as water testing charges, inspection charges, and some construction works

  However, (ii) is negligible due to the small amount of sales volume. Accordingly, water charges will determine the financial performance of the P-CERWASSs.

For the financial analysis, water charge is calculated in accordance with the tentative cost estimation of O&M for water supply system, by adding 15% mark-up of the O&M cost. Detailed information of the O&M cost is given in section 5.3.2, and Table 5.3.1 shows expecting water charges in each P-CERWASS.

Table 5.3.1 Expecting Water Charges in the four P-CERWASS

P-CERWASS	Water Charge (US$/M^3)
Phu Yen	0.225
Khan Hoa	0.159
Ninh Thuan	0.229
Binh Thuan	0.153
Average	**0.192**

(Remark) In case that a P-CERWASS has several project sites, the highest O&M cost shall be adopted for the calculation of water charges.

For reference, water charges in each project site vary due to the difference of the conditions such as water source, treatment method, and population distribution. However, all the proposed water charges could be fully acceptable to water users in the projected areas in consideration of the results of socio-economic survey and the existing water tariffs, which are between 1,000 to 3,000VND/M^3.

- The expected income will increase in proportion to the volume of the estimated annual consumption. Detailed data on annual consumption is given in section 5.1, and the consumption amount has been deducted 10% from the annual production as water loss.

As for the calculation of net profit - The following taxes are deducted from the projected income;

Table 5.3.2 Expected Taxes

P-CERWASS	Type of Taxes
Binh Thuan	Profit Tax 5% on income of water supply
Phu Yen, Khan Hoa, and Ninh Thuan	License tax (approx. 1 million VND)*

(*Remark) License Tax is neglected from the calculation of financial analysis due to the small amount.

b. Expenditure

- For the investment (project) cost, the detailed information is given in the section 5.3.
- The same as the calculation of the projected income, O&M cost shall also be increased in proportion to the volume of the estimated annual consumption.

Note that inflation rate or price contingency shall not be considered for the income and expenditure statement to avoid arbitrariness and project life for the financial analysis is assumed as 26 years (2011 to 2037).

Table 5.3.3 Financial Analysis - Projected Income and Expenditure Statement and NPV

#	Year	Total Cost (US$)			[D] Net Income (US$)	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	37,336,100	0	37,336,100	0	-37,336,100	-37,336,100
2	2012	0	419,600	419,600	572,005	152,405	148,688
3	2013	0	426,037	426,037	580,217	154,180	146,751
4	2014	0	432,651	432,651	588,826	156,174	145,023
5	2015	0	439,445	439,445	597,494	158,049	143,184
6	2016	0	446,052	446,052	606,024	159,972	141,392
7	2017	0	453,236	453,236	615,162	161,926	139,628
8	2018	0	460,163	460,163	624,086	163,923	137,903
9	2019	0	467,220	467,220	633,251	166,031	136,269
10	2020	0	474,739	474,739	642,747	168,008	134,529
11	2021	0	482,244	482,244	652,448	170,204	132,963
12	2022	0	489,747	489,747	661,959	172,212	131,250
13	2023	0	497,441	497,441	671,856	174,415	129,687
14	2024	0	505,193	505,193	681,729	176,537	128,063
15	2025	0	513,302	513,302	692,078	178,775	126,524
16	2026	0	521,440	521,440	702,419	180,980	124,960
17	2027	0	529,663	529,663	712,988	183,325	123,492
18	2028	0	538,146	538,146	723,804	185,658	122,013
19	2029	0	546,652	546,652	734,569	187,917	120,486
20	2030	0	555,105	555,105	745,291	190,187	118,967
21	2031	0	564,071	564,071	756,727	192,656	117,572
22	2032	0	573,015	573,015	768,061	195,046	116,128
23	2033	0	582,335	582,335	779,992	197,657	114,812
24	2034	0	591,681	591,681	791,778	200,097	113,395
25	2035	0	601,097	601,097	803,789	202,691	112,063
26	2036	0	610,985	610,985	816,313	205,328	110,752
27	2037	0	620,860	620,860	828,870	208,009	109,462
		37,336,100	**13,342,120**	**50,678,220**	**17,984,483**	**-32,693,738**	**-34,010,142**
						FIRR=	**-11.4%**

(2) FIRR

FIRR is calculated by using the following formula:

$$\sum_{t=1}^{n} R_{t-1} / (1+d)^{t-1} = 0$$

Where d: FIRR t: The t the year
R: The value in each year n : The 26th year (up to 2037)

Subsequently, the FIRR will be compared with the opportunity cost of capital (OCC). The risk-free interest rate, namely that of Treasury bills or public bonds, is generally used as the OCC. In case of Vietnamese financial market, the interest rate of the Treasury bill is around 7 to 10%. In the meanwhile, as shown in Table 5.3.4, the FIRR of total project is -11.4%, and other results of the calculation for the nine project sites are as follows;

Table 5.3.4 Result of FIRR

	FIRR
Total	**-11.4%**
(By P-CERWASS)	
FPS-2	**-8.6%**
FPS-3	**1.8%**
FPG-4	**-15.0%**
FPS-5	**-0.1%**
FKS-6	**-8.7%**
FKS-8	**-15.1%**
FNG-10	**-14.5%**
FBS-11	**-14.5%**
FBG-13	**-18.3%**

More detailed information on the results of FIRR in each P-CERWASS is shown in ANNEX 7.

What the result of the financial analysis shows is that the Project could be infeasible in terms of financial aspects, however, it also means;

- Substantial problem in financing the project cost is how to arrange the initial investment cost
- Net income can cover O&M cost

In other words, the Project can be feasible if only the investment cost or construction cost of facilities are raised from any fund sources. In a sense, the Project should be implemented by using grant scheme.

Furthermore, sensitivity analysis was also conducted to check the two cases (double and treble of the proposed water charge) of water charges. The result of the calculation is shown in Table 5.3.5. As the result indicates, in all cases the FIRR can be improved drastically by increasing the water charge.

Table 5.3.5 Sensitivity Analysis

Uni Price (US$/M³)		FIRR
0.153 to 0.225	(Proposed Tariff)	-11.40%
0.306 to 0.450	(Proposed Tariff) x 2	-3.2
0.459 to 0.675	(Proposed Trriff) x 3	0.6%

(3) NPV

In addition to the FIRR analysis, NPV was also calculated by using the following formula, for the reference in evaluating the investment.

$$\sum_{t=1}^{n} \frac{C_t}{(1+r)^i} - C_0$$

Where C_t : Net cash flow at that point in time t: The t the year

C_0 : Cost of the project at the beginning

n : The 26th year (up to 2037)

As shown in Table 5.3.3, NPV is US$ -34 million at the discount rate of 2.5%, which is taken as the interest rate of the standard IDA terms.

(4) Study on water charges

According to the above financial analysis of the Project, the increase in water charges is imperative in order to improve financial condition of the Project. The following Table 5.3.6 explains the comparison of the proposed water charges, Willingness to Pay (WTP), Affordable to Pay (ATP) and water charges including depreciation cost by P-CERWASSs. In the table, difference between the proposed water charges and the three indices can be clearly articulated and referred as fundamental idea of the future tariff system.

Table 5.3.6 Comparison of the Proposed Water Charges and the Three Indices

(Unit : US$/m³)

	Phu Yen		Khan Hoa		Ninh Thuan		Binh Thuan	
Proposed Water Charges	**0.225**	**(100%)**	**0.159**	**(100%)**	**0.229**	**(100%)**	**0.153**	**(100%)**
1) Willingness to Pay*	0.179	80%	0.197	124%	0.214	93%	0.184	120%
2) Affordable to Pay**	0.546	242%	0.684	430%	0.571	249%	0.908	593%
3) W.Charges inc. depreciation***	0.528	235%	0.468	294%	0.742	324%	0.487	319%

(Remarks: For the detailed information, refer to the "Supporting Report".)

*Willingness to Pay --- Figures is excerpted from the socio-economic survey conducted by the Study Team.

**Affordable to Pay --- 5% of monthly expenditure per household. Figures is excerpted from the socio-economic survey conducted by the Study Team.

***W. Charges inc. depreciation --- Proposed water charge + depreciation cost/m³

In fact, as mentioned in the section 5.3.1, the proposed water charge is calculated in accordance with the tentative cost estimation of O&M in each water supply facility, by adding 15% mark-up of the cost, and is taken into consideration of the price level of WTP and the existing water charges. Hence, the WTP is proximate to the proposed water charges in each P-CERWASS. Meanwhile, the ATP shows much affordability and possibility to increase water charges in the near future (eg. 242% to 593% of the proposed water charges). In other word, the proposed water charges and the WTP can

be recognized as low if comparing with the ATP. Finally, for the further reference, water charges including the estimated depreciation on facilities are calculated on the basis of designated condition in the Supporting Report since the O&M expenditure calculated in the financial analysis does not include depreciation and future investment costs. As the comparison table concludes that the water charges including the depreciation cost in the four P-CERWASSs except Ninh Thuan could be covered by the price level of the ATP.

In addition the above comparison, another comparison of profit growth ratios of the three cases is summarized in Figure 5.3.1. As shown in the graph, although the survey results of willingness to pay indicate that water users prefer to pay around the proposed water charge level, its growth rate remains low during the project life.

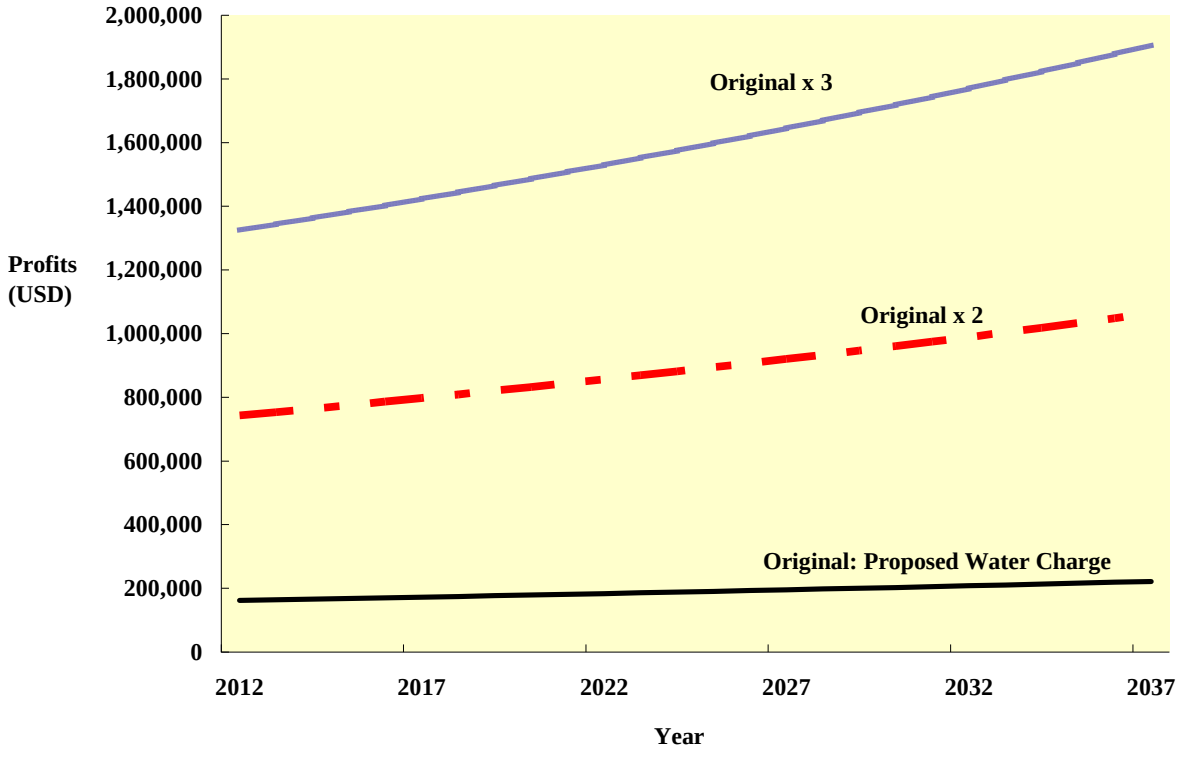

Figure 5.3.1 Comparison of the three cases of water charges

On the other hand, the growth rates of other two water charges, double and treble of the proposed water charges, are predicted higher than that of original case.

On the basis of the above speculation and surmise, each P-CERWASS could have room to increase water charges and it also could have a positive impact on the financial condition of the organizations. In conclusion, in order to cover the additional costs such as depreciation and future investment cost, water charges need to be raised gradually from the current unit price.

As for the support to poor and socially vulnerable such as ethnic minority groups, some assistance measures have already been conducted by each PPC and P-CERWASS respectively. For instance, reduced water charges are applied at all the minority people in the four Provinces and small-scaled water supply facilities such as dug-well and tube-well are donated to minority community by using the fund of program 134/135. Economic disparity can still be seen in some parts of the targeted four Provinces, and it is, therefore, important to continue the remedial action for the people who are suffering from poverty and social inequality.

(5) Economic Analysis

Economic benefits of the proposed project, which would contribute to the society of the targeted four Provinces on the whole, are examined as below. The Project's eventual goal is to serve safe and stable water supply of 60 liter to all the inhabitants in the targeted areas by 2020. At present there are no modern water facilities in the targeted areas, resulting in low water coverage ratio in the four Provinces. Under the distressing condition, proposed project can contribute to economic and social activities in the areas through supplying water safely and stably.

It is, however, quite difficult to evaluate and quantify the economic benefits in consideration of the project location that is rural and farming community. Thus, the economic benefits shall be measured qualitatively. The proposed project is expected to create those benefits;

(a) Resource cost saving by the project

- A shift away from use of alternative water resources, which are thought to be expensive, such as water from private venders, private boreholes, and other commercial water products

(eg.) Comparison of water charges

Water prices of private venders : US$ 1.18 to 1.78 /m^3	⇒	Proposed water charges in the Study: US$ 0.153 to 0.229 /m^3

- Fairness of water access

(eg.) Time required for fetching water in the four Provinces

Time	Less than 5 min.	5 to 10 min.	10 to 30 min.	30 to 60 min.	More than 60 min.
(%) of population	51.8	15.9	6.2	2.2	5.1

(Source: Socio-Economic Survey conducted by the Study Team)

- Cost saving by eliminating or reducing the need for private water supply facilities and including installation of storage tanks, pipes and pumping system, and electricity expenses

(eg.) Standard marketing prices of water supply facilities for individuals

Item	Standard Marketing Prices (VND)
Installation cost on dug well construction	2.5 million to 4 million

Installation cost on tube well construction	10 million or more
PVC pipe (50 mm to 300 mm dia.)	15,600 to 689,000/m
Cast Iron Pipe (100 mm to 300 mm dia.)	555,000 to 1,293,000/m
Steel Pipe (50 mm to 300 mm dia.)	112,000 to 1,482,000/m

- Cost saving through lowering of health care or medical expenses for water borne diseases which are caused by low water quality (For the detailed information on the water borne diseases in the targeted four Provinces, refer to the Table 2.2.5 of the Chapter 2)

- Enhancement of social status of women who are supposed to take on fetching water and saving the time for fetching water leads to gender equality on education
(eg.) Youth literacy rate (aged 15 to 24, 2004) with comparison of East Asia and Pacific region

	Vietnam	**East Asia and Pacific**
Female	93.6	97.5
Male	94.2	98.2

(Source: World Bank)

- Decrease of the child mortality and morbidity rate which are stemmed from low water quality
(eg.) Basic indicators of child mortality and morbidity (2006)

Indicators	**Under-5 Mortality Rate**	**Under-1 Mortality Rate**	**Under-5 with Diarrhea**
(%) of population	17	15	65

(Source: UNICEF)

(b) New demand generated by the project
- Increase of water tariff collection rates
- Increase of money collected as water tariffs
- Increase of new connections to the water supply

Other indirect benefits, such as poverty reduction and environmental improvement, can also be expected from the project. However, in order to analyze economic benefits precisely, an extensive economic-social survey will be required at the next stage of project preparation.

(6) Conclusion

In conclusion of the financial and economic analysis in the Study, although financial analysis indicates that the Project would be financially infeasible, O&M costs can be coved by the expecting net income from water charges if initial investment (construction) cost are raised from any fund sources. Moreover, according to the result of socio-economic survey conducted by the Study Team, the ATP in the targeted four Provinces is much higher than the proposed water charges which mainly

refer to the WTP. In other word, he proposed water charges and the WTP can be recognized as low if comparing with the ATP, and if water charges could increase at the ATP levels, it could cover even depreciation costs in most cases in the Project. Overall, there could still be possibility to increase water charges in order to improve the financial condition in each P-CERWASS.

In addition to the financial analysis, economic analysis ascertains that the Project can contribute to the social and economic development for the entire society in the targeted four Provinces, and the significance of the Project can fit to the concept of Basic Human Needs (BHN) and poverty reduction.

On the whole, the Project should be implemented regardless of the negative result of the financial analysis, in consideration of social and economic benefits impacting a wide range of people's lives.

5.3.2 Organizations and O&M

As shown in the section 3.3.3, capacity assessment was conducted to identify the strength and weakness of the four P-CERWASSs by means of SWOT analysis and checklist of the comprehensive capacity assessment prepared by the Study Team. As a result of the assessment and the past analogous projects in Northern and Central Highland Provinces, the following major organizational issues are highlighted;

(1) In Phu Yen and Khan Hoa Provinces, there is no modern water supply facility in the projected areas, and the two P-CERWASSs, naturally, lack of sufficient experience and know-how of the management of modern water facilities. So far, the duties and responsibilities of the two P-CERWASSs are limited to designing and planning works.

(2) N-CERWASS also needs more experienced staffs that can cover all rural water supply services throughout the country.

(3) In some communes, IEC activity is not yet fully implemented and the lack of knowledge of water supply leads to non-payment of water charges and declining of hygienic consciousness.

(4) As for the financial aspect, profitability of each facility varies due to the gap between differential production costs and nearly same selling price. As a result of the widening disparity, it is quite difficult for the deficit-ridden facilities to move into black.

To deal with the issues (1), (2) and (3), establishment of the proposed structure in Figure 3.3.3, and well-organized CD as the Study Team recommended in the section 3.3.6 should be smoothly carried out. With regard to the issue (4), as Ninh Thuan and Binh Thuan P-CERWASSs have already put this into practice, uniform management of a number of facilities could be one of the effective measures to redress the profitable balance between the red-ridden and the surplus facilities. In addition to that, it is also important for the facilities in the red to reconsider the water charges.

O&M teams should be formed under P-CERWASS to perform daily O&M of facility, billing and water charge collection in commune level. The typical composition of the O&M team by the proposed water supply facility is tentatively presented as Table 5.3.7, which consists of chief, technician, operator, casher and meter reader.

Table 5.3.7 O&M Team Composition by Water Supply Facility

Province	Facility	Job title and staff number (person)					
		Chief	Technician (Mechanic)	Operator	Casher	Meter reader	Total
Phu Yen	FPS-2	1	1	2	1	1	6
	FPS-3	1	1	1	1	1	5
	FPG-4	1	1	2	1	1	6
	FPS-5	1	1	1	1	1	5
Khanh Hoa	FKS-6	1	1	2	1	1	6
	FKS-8	1	1	2	1	1	6
Ninh Thuan	FNG-10	1	2	3	2	6	14
Binh Thuan	FBS-11	1	1	2	1	1	6
	FBG-13	1	3	6	4	12	26

(Note)
The composition and staff number is tentatively presented as a typical case. It should be reviewed and decided by P-CERWASS in the implementation phase, when detailed facility design, customer numbers, etc. will be decided.

Main duties and required skills by position are presented as Table 5.3.8. It is envisaged that the staff would be employed by P-CERWASS. P-CERWASS should ensure sufficient knowledge and skills through provision of training to the staff. In case of Phu Yen and Khanh Hoa provinces, there are no water supply systems managed under P-CERWASS. Therefore, outside resources should be utilized to train the key staff. In this regard, technical assistance for Phu Yen and Khan Hoa P-CERWASS is provided by Binh Thuan and Ninh Thuan respectively, who have management experience and training program in their organization.

In addition to regular training course provided by P-CERWASS, OJT (On-the-job) training should be provided during implementation period, in order to acquire skills through actual facility operation, which natively differs by facility to facility.

Table 5.3.8 Main duties and required skill

Job title	Duty	Skills
Chief	- Check daily report - Prepare weekly report to P-CERWASS - Customers relations	- Leadership, responsibility and reliability - Knowledge on water supply system (function of facility, water billing and collection system, etc.) - Communication skill - Reporting skill (regular report, identifying problems)
Technician	- Daily maintenance - Minor repair work - Keeping maintenance record	- Knowledge on water supply facility (name, number, specification, function, etc.) - Basic technical skill (plumbing and mechanical) - Basic reporting skill (using template

		format)
Operator	- Daily operation - Keeping daily report	- Basic technical knowledge and skill of operating facility - Basic reporting skill (using template format)
Casher	- Keeping water ledger - Issuing water bill - Keeping account book	- Basic accounting knowledge - Communication skill
Water meter reader	- Water meter reading - Distributing water bill - Collecting water charge	- Technical knowledge on water meter - Communication skill

5.3.3 Environmental and Social Considerations

(1) Objective of the Initial Environmental Examination Study

The purpose of the Initial Environmental Examination (IEE) is to ensure that development options under consideration are environmentally and socially sound and sustainable and that the environmental consequences of the project are recognized early and taken into account in the project design. The procedure should follow the Vietnamese legal frameworks, and JICA's Guidelines for Environmental and Social Considerations are also taken into account.

The major objective of IEE is to establish present environmental and social conditions of the project area through available data/information to predict the impacts on relevant environmental and social attributes due to the construction and operation of the proposed water supply system, to suggest appropriate and adequate mitigation measures to minimise/reduce adverse impacts.

Considering the nature and social conditions of this Project, the strategic environmental assessment (SEA) and the environmental impact assessment (EIA) for selected water supply projects of the Feasibility Study are not required for the following reasons. However, Environmental Protection Commitment (EPC) is required for implementation of these projects instead of SEA and EIA. (Refer to Chapter 2.6 for the details of EPC)

Table 5.3.9 Requirement of Environmental and Social Considerations in Vietnam for the Water Supply Project

Prescribed Project with Requirement of Environmental Considerations	Outline of Selected Water Supply Projects for the Feasibility Study
< Condition of SEA requirement > • National socio-economic development strategies and plans; • Strategies, planning and plans for development of branches or domains on a national scale; • Socio-economic development strategies, planning and plans of provinces, centrally run cities or regions; • Planning for land use, forest protection and development; exploitation and utilization of other natural resources in inter-provincial or inter-regional areas; • Planning for development of key economic regions; • General planning of inter-provincial river watersheds.	The study areas are located in 15 candidate communes of four (4) provinces. These projects are rural water supply and these project areas are not planned across the provincial area. Therefore, SEA is not required.
< Condition of EIA requirement > • Projects of national importance; • Projects planned to use part of land of or exerting adverse impacts on, the natural sanctuaries, national parks, historical and	These project areas do not include natural preserve and historical /cultural areas, and the environment impacts are minor due to small size

cultural relic sites, natural heritages or beautiful landscapes; • Projects to potentially exert adverse impacts on the river watershed, coastal areas or areas of protected ecosystems; • Projects to construct new urban centers or concentrated residential areas; • Projects to exploit and use groundwater or natural resources on a large scale; • Projects to exploit groundwater with a capacity of 10,000m^3/day or more.	facility of rural water supply. Water source of four (4) water supply projects among nine (9) systems is groundwater. The planned groundwater exploitation (daily average) ranges from 485 m^3/day to 998 m^3/day in 2020. Therefore, EIA is not required.
< Condition of EPC requirement > • Projects except for the aforementioned projects.	EPC is required for selected projects for the Feasibility Study.

The IEE in this study was carried out for selected water supply projects under the Feasibility Study (nine (9) systems out of 13 systems of M/P). Four (4) systems of M/P were not selected for the F/S due to the following problems.

- Between water intake point and water service area of such commune, there are other communes that have no water supply system.
- Since the distance to water intake point is long, economical efficiency is low.
- The commune adjoins the service area of other urban water supply.

For these reasons, it is judged that the examination of the alternatives which covers the Study area including other communes is required again. Consequently, IEE was undertaken only for selected projects for the Feasibility Study.

(2) Baseline Data of Existing Environmental Conditions

Based on results of data collection and socio-economic investigation, the existing environmental conditions of selected commune for the Feasibility Study are shown from Table 5.3.10 to Table 5.3.15.

Table 5.3.10 Baseline Data Existing Environmental Conditions (1)

Province	Phu Yen	Phu Yen	Phu Yen
Commune	An Dinh (P-2)	An My (P-4)	Son Thanh Dong (P-8)
Water Supply System	FPS-2 (Pattern: Single)	FPS-3 (Pattern: Single)	FPS-5 (Pattern: Single)
Area (km^2)	17.9	13.8	179.7
Population	5,964 (2006) 6,856 (2020)	11,427 (2006) 13,256 (2020)	8,240 (2006) 9,292 (2020)
Population growth rate	1.2 %	1.2 %	1.2 %
Ethnic group	100.0 % (Kinh)	100.0 % (Kinh)	100.0 % (Kinh)
Poverty Ratio (%)	13.9 %	9.7 %	25.0 %
Monthly household expense (x1000 VND/month)	1,527 (average) 1,450 (median)	1,951 (average) 1,585 (median)	1,953 (average) 1,725 (median)
Percentage of expense on water among monthly budget in dry season	Less than 5%: 69.6 % From 5 % to 10%: 28.5 % More than 10%: 1.9 %	Less than 5%: 99.6 % From 5 % to 10%: 0.4 % More than 10%: 0.0 %	Less than 5%: 100.0 % From 5 % to 10%: 0.0 % More than 10%: 0.0 %
Waterborne Disease Diarrhea:	11.6 %	0.7 %	15.9 %

Cholera: Dysentery: Hepatitis: Malaria: Schistsome: Trachoma: Skin diseases: Other: No contracts: (multiple answers)	3.9 % 0.0 % 1.9 % 3.2 % 1.9 % 8.4 % 8.6 % 8.4 % 69.0 %	1.4 % 0.0 % 1.4 % 0.7 % 1.1 % 0.4 % 2.1 % 1.8 % 92.2 %	1.6 % 1.1 % 2.1 % 14.8 % 1.1 % 3.2 % 13.2 % 0.0 % 67.2 %
Water Source Piped water Dug well Tube well Spring River / stream Rain water Purchase Others	 0.0 % 82.6 % 15.5 % 1.9 % 0.0 % 0.0 % 0.0 % 0.0 %	 0.0 % 55.7 % 42.2 % 0.0 % 0.0 % 0.0 % 0.0 % 2.1 %	 0.0 % 33.3 % 63.5 % 0.0 % 1.1 % 1.6 % 0.0 % 0.5 %
Water volume of use	121 lcd (average) 83 lcd (median)	70 lcd (average) 50 lcd (median)	74 lcd (average) 50 lcd (median)
Served population of the existing water supply system	0	0	0
Geomorphology	The commune area consists of low land and low mountains. The villages are located on a valley plain. People live on the foot of small mountain in the valley and the bottom of the valley near “Cai” river.	The commune area mainly consists of coastal plain. The foot of mountainous area is in the western part and small mountains are distributed in north end. The main residential area is located near the sea coast. The people live on sand dune, natural levee and foot of small mountains. There is a big swamp in the center of the commune during rainy season.	One half of the commune (northern part) mainly consists of table land and some residual hills. The other half mainly consists of mountainous area.
Geology	The surface geology of the low land (valley plain) is sedimentary deposit and the base rock is basalt. The mountainous area consists of basalt and plutonic rocks.	The main geology of the commune is sedimentary deposit in the plain. The mountains mainly consist of plutonic rocks, and partially of basaltic rock that is widely distributed in adjacent area.	The table land mainly consists of volcanic rocks such as basalt. The residual hills mainly consist of sedimentary rocks. The mountainous area consists of plutonic rocks, and the sedimentary rocks are distributed at the edge of the mountains.
Hydrology (Current state of surface water and groundwater)	Tow tributaries of “Cai” river run through the commune, namely, “suoi Cay” and “Dong Su”. These rivers flow from south to north. Fifty percent of the	The water resources dry up from June to August. A large swamp and a river flow from western part emerge during rainy season. Ninety percent of the	The water resources dry up in dry season. Here are tow rivers and two ponds. Water of one river is utilized for hydraulic electric power generation. The other

	households have their own dug wells. Some wells have fluoride and metallic taste in the water.	households have their own dug wells. Some wells have salinity, fluoride and odor in the water.	is not used. Waters of two ponds are used for irrigation. Fifty five percent of the households have their own dug wells. Spring water is also used for irrigation.
Climate and Meteorology (Precipitation)	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,800 mm to 1,900 mm.	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,800 mm to 1,900 mm.	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,800 mm to 2,200 mm.
Nature Conservation Areas	Non	Non	Non

Table 5.3.11 Baseline Data Existing Environmental Conditions (2)

Province	Phu Yen	Phu Yen	Phu Yen
Commune	Son Phuoc (P-5)	Ea Cha Rang (P-6)	Suoi Bac (P-7)
Water Supply System	FPG-4 (Pattern: Group)	FPG-4 (Pattern: Group)	FPG-4 (Pattern: Group)
Area (km^2)	28.4	83.1	40.5
Population	3,261 (2006) 4,071 (2020)	2,583 (2006) 3,072 (2020)	5,626 (2006) 6,411 (2020)
Population growth rate	1.2 %	1.2 %	1.2 %
Ethnic group	42.0 % (Kinh) 34.8 % (Hroi) 23.2 % (Other)	44.1 % (Kinh) 50.8 % (Ede) 5.1 % (Other)	69.7 % (Kinh) 27.6 % (Hroi) 2.8 % (Other)
Poverty Ratio (%)	28.2 %	41.0 %	30.0 %
Monthly household expense (x1000 VND/month)	3,519 (average) 3,175 (median)	3,023 (average) 2,536 (median)	2,048 (average) 1,945 (median)
Percentage of expense on water among monthly budget in dry season	Less than 5%: 100.0 % From 5 % to 10%: 0.0 % More than 10%: 0.0 %	Less than 5%: 98.3 % From 5 % to 10%: 1.7 % More than 10%: 0.0 %	Less than 5%: 99.3 % From 5 % to 10%: 0.7 % More than 10%: 0.0 %
Waterborne Disease			
Diarrhea:	78.3 %	79.7 %	0.0 %
Cholera:	1.4 %	1.7 %	0.0 %
Dysentery:	0.0 %	0.0 %	0.0 %
Hepatitis:	1.4 %	1.7 %	0.0 %
Malaria:	55.1 %	40.7 %	0.0 %
Schistsome:	30.4 %	54.2 %	0.0 %
Trachoma:	10.1 %	15.3 %	0.0 %
Skin diseases:	20.3 %	39.0 %	0.0 %
Other:	2.9 %	5.1 %	0.0 %
No contracts:	11.6 %	6.8 %	100.0 %
(multiple answers)			
Water Source			
Piped water	5.8 %	0.0 %	21.4 %
Dug well	88.4 %	52.5 %	77.9 %
Tube well	0.0 %	0.0 %	0.0 %
Spring	2.9 %	28.8 %	0.7 %
River / stream	0.0 %	0.0 %	0.0 %

Rain water Purchase Others	2.9 % 0.0 % 0.0 %	6.8 % 0.0 % 11.9 %	0.0 % 0.0 % 0.0 %
Water volume of use	72 lcd (average) 33 lcd (median)	77 lcd (average) 64 lcd (median)	99 lcd (average) 75 lcd (median)
Served population of the existing water supply system	777 (Organization: CPC)	772 (Organization: CPC)	600 (Organization: Urban Water Supply)
Geomorphology	The commune is mainly located on table land with gentle slope surrounded by foothills.	The commune is mainly located on undulating table land with gentle slope surrounded by foothills and residual small mountains.	The commune is mainly located on table land with gentle slope. Northeastern part of the commune consists of mountainous area.
Geology	The table land consists of basalt and its weathered parts, and the foothills consist of plutonic rocks. Plutonic rocks are massive. Sedimentary deposit is distributed at the head of the table land.	The table land mainly consists of basalt and its weathered parts. The foothills and residual small mountains consist of massive plutonic rocks. Granitic rocks are distributed near the edges of the foothills.	The table land mainly consists of basaltic rock and its weathered parts, and sedimentary deposit is partially distributed along a river. The mountainous area consists of plutonic rocks and granite.
Hydrology (Current state of surface water and groundwater)	The water resources dry up in dry season. Here is a trace of a stream but it is not confirmed because the season of the site survey was dry season. Thirty percent of the households have their own dug wells. Some wells have odor in the water.	The water resources dry up in dry season. Hear are no explicit surface waters. Eighty five percent of the households have their own dug wells. Some wells have fluoride, calcium and high pH in the water.	The water resources dry up from May to August. Here are one pond for irrigation and “Bac” river. Twenty percent of the households have their own dug wells. Some wells have calcium in the water.
Climate and Meteorology (Precipitation)	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,800 mm to 1,900 mm. Pan evaporation:	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,800 mm to 1,900 mm.	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,800 mm to 1,900 mm.
Nature Conservation Areas	Non	Krong Trai Special-use Forest	Non

Table 5.3.12 Baseline Data Existing Environmental Conditions (3)

Province	Khanh Hon	Khanh Hon	Ninh Thuan
Commune	Cam An Bac (K-1)	Cam Hai Tay (K-3)	Phuoc Hai (N-5)
Code of Water Supply System	FKS-6 (Pattern: Single)	FKS-8 (Pattern: Single)	FNG-10 (Pattern: Group)
Area (km^2)	20.5	19.2	32.5
Population	6,316 (2006)	5,745 (2006)	12,881 (2006)

	8,355 (2020)	6,978 (2020)	16,804 (2020)
Population growth rate	1.7 %	1.7 %	2.4 %
Ethnic group	100.0 % (Kinh)	100.0 % (Kinh)	69.6 % (Kinh) 30.4 % (Cham)
Poverty Ratio (%)	22.0 %	9.0 %	16.0 %
Monthly household expense (x1000 VND/month)	2,219 (average) 2,034 (median)	2,555 (average) 1,947 (median)	1,794 (average) 1,645 (median)
Percentage of expense on water among monthly budget in dry season	Less than 5%: 67.4 % From 5 % to 10%: 2.6 % More than 10%: 0.0 %	Less than 5%: 60.4 % From 5 % to 10%: 26.5 % More than 10%: 13.1 %	Less than 5%: 99.6 % From 5 % to 10%: 0.4 % More than 10%: 0.0 %
Waterborne Disease			
Diarrhea:	22.2 %	0.0 %	9.1 %
Cholera:	1.7 %	0.0 %	0.9 %
Dysentery:	0.0 %	0.0 %	0.0 %
Hepatitis:	4.3 %	0.0 %	0.0 %
Malaria:	5.1 %	0.0 %	0.4 %
Schistsome:	23.1 %	0.0 %	0.0 %
Trachoma:	13.7 %	0.0 %	3.0 %
Skin diseases:	37.6 %	0.0 %	6.1 %
Other:	22.2 %	0.0 %	21.7 %
No contracts:	27.4 %	100.0 %	66.1 %
(multiple answers)			
Water Source			
Piped water	0.0 %	0.0 %	0.4 %
Dug well	94.0 %	68.7 %	71.7 %
Tube well	0.0 %	0.0 %	0.0 %
Spring	1.9 %	0.0 %	1.3 %
River / stream	0.0 %	0.0 %	0.0 %
Rain water	0.0 %	6.4 %	0.0 %
Purchase	0.0 %	24.9 %	0.0 %
Others	6.0 %	0.0 %	26.5 %
Water volume of use	117 lcd (average) 100 lcd (median)	108 lcd (average) 63 lcd (median)	65 lcd (average) 54 lcd (median)
Served population of the existing water supply system	1,305 (Organization: CPC)	0	4,581 (Organization: CPC)
Geomorphology	The commune is located at the head of the narrow valley plain close to the foot of mountainous area. The commune is located at the highest part in its catchment's area. Hear are mountain foots at left side and residual mountain at right side.	The commune is located on a flood plain in contact with a cove. The plain elevation near the sea is very low. Relatively higher and well drained lowland is distributed at the west part of the commune. There is a residual mountain northern outside of the commune.	The commune is located on relatively higher lowland, and sand dune is widely distributed in the south part of the commune. People live on the foot of the sand dune or sand dune itself.
Geology	The plain is underlain by thin sedimentary deposit. The base rock is plutonic rocks. The mountains mainly consist of plutonic rock, and partially of sedimentary rocks at southern	The surface of the flood plain consists of sandy sediment. The base rock is plutonic rock.	Surface geology is sand dune deposit and alluvial deposit. The base rock is plutonic rock.

	end of the commune.		
Hydrology (Current state of surface water and groundwater)	The water resources dry up from April to September. Here is no surface water during dry season. Eighty percent of the households have their own dug wells. Some wells have salinity and fluoride in the water.	The water resources dry up in dry season. Here is no surface water in the commune. Seventy percent of the households have their own dug wells. Some wells have salinity and fluoride in the water.	Here is a river named "Gia". The river flow into east. However, the river dris up during dry season. One spring water from sand dune is used for drinking water of one village through water supply system. Other spring waters converge to a stream and people of a village fetch their drinking water from the stream. Seventy percent of the dug wells in the commune have salty and metallic taste.
Climate and Meteorology (Precipitation)	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,500 mm to 1,600 mm.	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 1,500 mm to 1,600 mm.	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 900 mm to 1,000 mm.
Nature Conservation Areas	Non	Non	Non

Table 5.3.13 Baseline Data Existing Environmental Conditions (4)

Province	Ninh Thuan	Binh Thuan	Binh Thuan
Commune	Phuoc Dinh (N-6)	Muong Man (B-1)	Nghi Duc (B-3)
Code of Water Supply System	FNG-10 (Pattern: Group)	FBS-11 (Pattern: Single)	FBG-13 (Pattern: Group)
Area (km^2)	130.1	18.3	74.7
Population	8,549 (2006) 12,912 (2020)	5,977 (2006) 7,378 (2020)	10,192 (2006) 11,869 (2020)
Population growth rate	2.4 %	1.4 %	1.4 %
Ethnic group	98.7 % (Kinh) 1.4 % (Cham)	100.0 % (Kinh)	100.0 % (Kinh)
Poverty Ratio (%)	20.0 %	6.3 %	8.1 %
Monthly household expense (x1000 VND/month)	3,252 (average) 2,508 (median)	6,003 (average) 4,691 (median)	3,589 (average) 2,754 (median)
Percentage of expense on water among monthly budget in dry season	Less than 5%: 98.7 % From 5 % to 10%: 1.3 % More than 10%: 0.0 %	Less than 5%: 73.9 % From 5 % to 10%: 17.6 % More than 10%: 8.5 %	Less than 5%: 97.6 % From 5 % to 10%: 1.5 % More than 10%: 1.0 %
Waterborne Disease			
Diarrhea:	1.9 %	27.1 %	43.3 %
Cholera:	0.0 %	5.7 %	3.0 %
Dysentery:	0.0 %	4.3 %	0.0 %
Hepatitis:	0.0 %	2.9 %	5.4 %
Malaria:	1.3 %	7.9 %	21.2 %
Schistsome:	0.0 %	17.1 %	56.7 %

Trachoma: Skin diseases: Other: No contracts: (multiple answers)	1.9 % 1.3 % 28.5 % 72.8 %	25.0 % 30.0 % 12.1 % 52.1 %	35.5 % 43.8 % 30.5 % 18.7 %
Water Source Piped water Dug well Tube well Spring River / stream Rain water Purchase Others	 8.9 % 50.0 % 8.2 % 0.0 % 0.0 % 1.3 % 27.8 % 3.8 %	 0.0 % 39.3 % 4.3 % 0.0 % 3.6 % 34.3 % 3.6 % 15.0 %	 0.0 % 86.4 % 11.0 % 0.0 % 0.0 % 2.5 % 0.0 % 0.0 %
Water volume of use	134 lcd (average) 100 lcd (median)	219 lcd (average) 125 lcd (median)	158 lcd (average) 125 lcd (median)
Served population of the existing water supply system	1,717 (Organization: CPC)	0	0
Geomorphology	Mountains spread from south to west and north side near the center of the commune. The areas among these mountains are hills with gentle slope. Low land is distributed along a river at central part of the commune. The river flows through the commune from west to east between the mountainous areas. Main residential areas are distributed along the coast line. One village is on the low land at northwest of the commune.	The main geomorphology of the commune is low land. “Cai ” river flow through the center of the commune from south to east. A small mountain exists at the west end of the commune. The residential area is located along the river.	The commune consists of mountains at northern half and plain land at southern half. The residential area is on the plain land.
Geology	Mountains consist of plutonic rock (granite). Sand dune deposit overlies the plutonic rock at hill. Fault fracture zone with NW-SE direction may exists at south part of the mountains.	Sedimentary deposit spreads over low land with the maximum thickness of 15 m. The base rocks are plutonic rock and/or sedimentary rock.	Mountains consist of plutonic rock. Lineaments with NE-SW direction are distributed in mountainous area. Sedimentary deposit covers base rocks at plain land, but the thickness may be thin.
Hydrology (Current state of surface water and groundwater)	Here are three rivers. Those rivers dry up during dry season. Here are one drinking water supply system which water source is a spring, and one distribution reservoir with five big dug wells. Almost all parts of groundwater of dug wells have salty taste.	” Cai” river dries up during severe dry season. About 400 dug wells are distributed in 1,380 households of the commune. All dug wells produce groundwater with metallic taste and some with salty taste. Large parts of the wells dry up during dry season. In addition, about 300 drilled	Two rivers flow through the commune. One of them is water source for drinking water of the commune. One spring, which is two kilometers away from the CPC near a mountain stream, does not dry up even in dry season. Almost all households have their own dug wells, and those wells don’t dry up

		wells were installed for irrigation of dragon fruit; those don't dry up even in dry season.	even in dry season but ten percent of the wells decrease their productivities. The groundwater becomes cloudy during rainy season. The average depth of the wells is about 10 meters (maximum 15 m). Here are two private drilled wells.
Climate and Meteorology (Precipitation)	The rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation varies from 900 mm to 1,000 mm.	The rainy season begins in May and finish in October. Annual precipitation varies from 1,400 mm to 1,500 mm.	The rainy season begins in May and finish in October. Annual precipitation varies from 2,500 mm to 2,800 mm.
Nature Conservation Areas	Non	Non	Non

Table 5.3.14 Baseline Data Existing Environmental Conditions (5)

Province	Binh Thuan	Binh Thuan	Binh Thuan
Commune	Me Pu (B-5)	Sung Nhon (B-6)	Da Kai (B-7)
Code of Water Supply System	FBG-13 (Pattern: Group)	FBG-13 (Pattern: Group)	FBG-13 (Pattern: Group)
Area (km^2)	64.3	49.5	87.3
Population	13,250 (2006) 16,315 (2020)	8,175 (2006) 9,794 (2020)	11,436 (2006) 14,263 (2020)
Population growth rate	1.4 %	1.4 %	1.4 %
Ethnic group	97.0 % (Kinh) 3.0 % (Cham)	100.0 % (Kinh)	100.0 % (Kinh)
Poverty Ratio (%)	9.8 %	12.0 %	23.0 %
Monthly household expense (x1000 VND/month)	2,972 (average) 2,592 (median)	2,510 (average) 2,038 (median)	2,818 (average) 2,493 (median)
Percentage of expense on water among monthly budget in dry season	Less than 5%: 99.6 % From 5 % to 10%: 0.4 % More than 10%: 0.0 %	Less than 5%: 100.0 % From 5 % to 10%: 0.0 % More than 10%: 0.0 %	Less than 5%: 99.1 % From 5 % to 10%: 0.9 % More than 10%: 0.0 %
Waterborne Disease			
Diarrhea:	10.7 %	21.2 %	10.3 %
Cholera:	1.9 %	1.2 %	0.0 %
Dysentery:	0.0 %	0.6 %	0.9 %
Hepatitis:	1.9 %	9.7 %	0.4 %
Malaria:	7.4 %	2.4 %	5.6 %
Schistsome:	1.9 %	6.1 %	4.3 %
Trachoma:	0.7 %	17.0 %	4.3 %
Skin diseases:	4.1 %	17.0 %	6.8 %
Other:	12.2 %	23.0 %	4.7 %
No contracts:	58.1 %	46.7 %	79.9 %
(multiple answers)			
Water Source			
Piped water	0.0 %	0.0 %	0.0 %
Dug well	70.7 %	100.0 %	84.6 %
Tube well	24.1 %	0.0 %	6.8 %
Spring	0.0 %	0.0 %	0.0 %
River / stream	0.0 %	0.0 %	0.0 %

Rain water Purchase Others	0.0 % 0.0 % 5.2 %	0.0 % 0.0 % 0.0 %	5.1 % 0.0 % 3.4 %
Water volume of use	241 lcd (average) 200 lcd (median)	123 lcd (average) 83 lcd (median)	198 lcd (average) 167 lcd (median)
Served population of the existing water supply system	0	0	0
Geomorphology	The commune consists of mountains at northern half and plain land at southern half. The residential area is on the plain land.	The commune consists of mountains at northern half and plain land at southern half. The residential area is on the plain land.	The commune consists of mountains at northern half and plain land at southern half. The plain land has partly higher area. The residential area is on the plain land.
Geology	Mountains consist of plutonic rock and sedimentary rocks. Lineaments with NE-SW direction are distributed in mountainous area. Sedimentary deposit covers base rocks at plain land.	Mountains consist of plutonic rock and sedimentary rocks. Lineaments with NE-SW direction are distributed in mountainous area. Sedimentary deposit covers base rocks at plain land.	The mountains consist of plutonic rock with lineaments that have NE-SW direction. Basalt is distributed in an plain land with relatively higher elevation. The thickness of the basalt is estimated to be thin. Sedimentary rock is recognized at river beds located at the west end of the commune.
Hydrology (Current state of surface water and groundwater)	Here are a few rivers which dry up in dry season. All households have their own dug wells. The wells distributed at north part of the CPC tend to dry up in dry season. The water of the wells without drying up have metallic taste.	Here are a few rivers which dry up in dry season. All households have their own dug wells. In dry season, ten percent of them dry up, another ten percent are scarce in quantity, and the rest (80 %) have enough quantity. The waters of the wells without drying up have metallic taste.	Relatively big river flow down to the south at west end of the commune. The river sometimes dries up during severe dry season. Ninety percent of the households have their own dug wells. Some of them have metallic taste in dry season. Here are about ten drilled wells for individuals and three for mineral water factories.
Climate and Meteorology (Precipitation)	The rainy season begins in May and finish in October. Annual precipitation varies from 2,500 mm to 2,800 mm.	The rainy season begins in May and finish in October. Annual precipitation varies from 2,500 mm to 2,800 mm.	The rainy season begins in May and finish in October. Annual precipitation varies from 2,500 mm to 2,800 mm.
Nature Conservation Areas	Non	Non	Non

(3) Overall Impact Identification

Based on field survey and data collection, adverse impacts by implementation of projects and degree of impact were considered. The overall Impact Identification is shown in Table 5.3.15.

Table 5.3.15 Scope Matrix for Project Components

No.	Environmental Items	Intake facilities (Groundwater)		Intake facilities (Surface water)		Water Treatment Plant		Distribution Reservoir		Distribution Main		Water Supply
		CS	OS	CS	OS	CS	OS	CS	OS	CS	OS	OS
1	Involuntary resettlement	-	-	-	-	-	-	-	-	-	-	-
2	Local economy	-	-	-	-	-	-	-	-	-	-	C
3	Land use and utilization of local resources	B	-	B	-	B	-	B	-	-	-	-
4	Social institutions	-	-	-	-	-	-	-	-	-	-	-
5	Existing social infrastructures and services	C	-	C	-	C	-	C	-	C	-	-
6	Split of communities	-	-	-	-	-	-	-	-	-	-	-
7	Misdistribution of benefit and damage	-	-	-	-	-	-	-	-	-	-	-
8	Cultural heritage	-	-	-	-	-	-	-	-	-	-	-
9	Local conflict of interests	-	-	-	-	-	-	-	-	-	-	-
10	Water usage or water rights and rights of common	-	-	-	-	-	-	-	-	-	-	-
11	Public health condition	-	-	-	-	-	-	-	-	-	-	-
12	Hazards (risk) infection diseases such as HIV/AIDS	-	-	-	-	-	-	-	-	-	-	-
13	Topography and geographical features	-	B	-	-	-	-	-	-	-	-	-
14	Soil erosion	-	-	-	-	-	-	-	-	-	-	-
15	Groundwater	-	B	-	-	-	-	-	-	-	-	-
16	Hydrological situation	-	-	-	-	-	-	-	-	-	-	-
17	Coastal zone	-	-	-	-	-	-	-	-	-	-	-
18	Flora, fauna and biodiversity	-	-	-	-	-	-	-	-	-	-	-
19	Meteorology	-	-	-	-	-	-	-	-	-	-	-
20	Landscape	-	-	-	-	-	-	-	-	-	-	-
21	Global warming	-	-	-	-	-	-	-	-	-	-	-
22	Air pollution	-	-	-	-	-	-	-	-	-	-	-
23	Water pollution	-	-	-	-	-	-	-	-	-	-	-
24	Soil contamination	-	-	-	-	-	-	-	-	-	-	-
25	Waste	-	-	-	-	-	-	-	-	-	-	-
26	Noise and vibration	C	-	C	-	C	-	C	-	C	-	-
27	Land subsidence	-	-	-	-	-	-	-	-	-	-	-
28	Offensive odor	-	-	-	-	-	-	-	-	-	-	-
29	Bottom sediment	-	-	-	-	-	-	-	-	-	-	-
30	Accidents	C	-	C	-	C	-	C	-	C	-	C

Note:
cs: Indicates construction stage. os: Indicates operation stage.
A: Indicates that the development scheme is foreseen to have strong impact on the environmental element.
B: Indicates that the development scheme is foreseen to have some impact on the environmental element.
C: Indicates that the development scheme is foreseen to have minor impact on the environmental element.
- : No impact

(4) Impact Identification and Mitigation Measure

Based on the findings of the IEE, the following items should be considered as mitigation measures for project implementation. The adverse impacts described below are not fatal. If mitigation measures are taken properly, the adverse impacts will be satisfactorily controlled and minimized.

Local economy (water vender)

The operating activities of water vender exist in five communes (total number of water vender is less than 30 persons) among 15 selected communes for F/S. All water vending activities are the side job of the farmer, and are commonly practiced only during the dry season. The cow carriages and vehicles, which are mainly used for agricultural works, are used for water conveyance, and large investment has not been made for water vending business. Therefore, it can be judged that fundamental life economy is appropriated by the agricultural income.

To mitigate negative impact on these vendors, their employment as seasonal or part-time staff by the water service corporation and turn to full time farming and household practices by agricultural promotion are proposed.

Land use and utilization of local resources (land acquisition for project sites)

Altogether 27 project sites are proposed for water supply project, and of these 27 sites, 19 sites include land owned by private people. The land use situation of private use land is upland field for cassava and sugarcane (five sites), paddy field (one site) and fallow land (13 sites).

In Vietnam, compensation of land expropriation in public projects such as water supply project is clearly prescribed by the Law on Land and Decree. In these water supply projects, it is expected that proper and sufficient compensation including grant of alternative agricultural land is carried out based on the Vietnamese Law and Regulation, and it can be judged that the adverse impact on land users is eliminated.

Existing social infrastructures and services (disruptions of traffic situation)

In rural areas of Vietnam, prime mode of transportation is motorbikes rather than heavy vehicle. Therefore, during construction stage of distribution line, occupancy of roads by construction activities shall affect traffic situation. The occurrence of traffic accident is also expected particularly during morning and evening hours when the traffic experiences peak.

In such cases, if appropriate countermeasures are not undertaken, it is expected that serious traffic disturbance will occur. However, these are short-term impacts, and these can be reduced by appropriate construction site management including announcement and appropriate traffic control.

Groundwater / Topography and geographical features

From the results of the test borehole drilling survey, P-4, P-8, K-1 and K-3 communes were selected as the targeted project in the Feasibility Study in consideration of groundwater quality and

productivity of groundwater. The target aquifer of the boreholes in the water supply systems is quite different from the dug wells which most of all villagers fetch water.

Appropriate withdrawal volume is designed for the water supply project based on the pumping test results in the test boreholes drilling survey, and the target is fissure or weathered basement rocks. Therefore, adverse impacts such as draw down, seawater intrusion, land subsidence and so on, seem to be negligible. However, from a viewpoint of groundwater preservation, monitoring of groundwater quality and groundwater level is recommended. (See Table 5.3.16)

Water pollution (water pollution by domestic wastewater)

Disposal and discharge situation of domestic wastewater and water pollution situation of public water bodies has also been studied through field survey. It is judged from the result that there is no water pollution caused by implementation of water supply projects.

However, it is expected that volume of generated domestic wastewater will increase in future by increase in population, and to control resulting pollution installation of on-site treatment facilities (such as Leaching Pit) is recommended.

Noise and Vibration

During construction works in the project, some noise and vibration will be generated by heavy equipments for construction. These impacts will be limited to the construction period only and can be mitigated by adopting the following countermeasures:

- Equipment maintenance should be strengthened to keep the noise level low.
- Construction activities should be strictly prohibited at night such as between 8:00pm to 06:00am. (Actual time should be determined by the result of the stakeholder meeting or based on instruction from CPC.)
- Polite operation and speed control are effective in reduction of the adverse impacts.

Accidents (war residual substances and water pollution and contamination by accident)

During construction and operation stage of the water supply project, some accidents by the war residual substance and hazardous substance outflow are expected. As countermeasures, a clearance of war residual substances is required to avoid any accidents due to war residual substances. For the water contamination accident by hazardous substance, water quality monitoring (see Table 5.3.16), establishment of an urgent communication network and preparation of the operations manual for emergency situation are proposed.

Table 5.3.16 Preliminary Monitoring Programme

Object		Monitoring Point	Parameters	Frequency
Water Supply System (Water source: groundwater and surface water)	Water quality (Raw water)	Water treatment plant	Basic parameters (1): Appearance, pH, EC, Turbidity	Daily for basic parameters (1)
	Water quality (Distributed water)	Water treatment plant	Basic parameters (2): Appearance, pH, EC, Turbidity, Taste, Residual Chlorine Basic parameters (3): Escherichia Coli (E. Coli), Fe, Mn, Hardness, etc. Hazardous substances and Others: The parameters and frequency should be determined upon consultation with Ministry of Health.	- Daily for basic parameters (2) - Three or four times a year for basic parameters (3) - Once in a year for hazardous substance
	Water quality and others (Tap water)	Selected house connections	Water pressure, pH, Turbidity, E. Coli, Residual Chlorine, etc.	- Optional
Water Supply System (Water source: groundwater)	Groundwater level	Monitoring well	Groundwater level	Daily

CHAPTER 6 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

(1) Water supply plan

The Study coincides in objective of National Rural Clean Water Supply and Sanitation Strategy (NRWSSS) as national plan and the study expects to generate synergistic effect by keeping pace with National Target Program (NTP and NTP 2). As a result of FS study as a short program, the water supply system planed 15 communes in 4 provinces. Hereby, People with 144,317 in the study area are expected to improve living conditions and promotion of sound socio-economic activities through the project by providing sufficient water.

(2) Groundwater development

The groundwater potentiality of each target commune has been evaluated through the investigation of the Study. The water supply system for only three (3) communes in Phu Yen and Khanh Hoa is fully applied groundwater. However, the water source of one (1) commune in Khanh Hoa is planed to combine groundwater and surface water. The water intake of other communes was planed by surface water as the alternative water source.

(3) Water supply management

At the moment, the operation and maintenance of water supply systems is conducted by P-CERWASSs in Ninh Thuan and Binh Thuan Provinces, meanwhile, it is managed by local communes in Phu Yen and Khan Hoa Provinces since the P-CERWASSs' responsibility is to focus on planning and designing of the systems, not including the management of the facilities. However, the results of the site survey indicate that it is quite difficult for local communes to operate and maintain a modern water supply facilities as the Study Team proposed due to the lack of human and financial resources. Thus, the Study Team strongly recommends the two P-CERWASSs, Phu Yen and Khanh Hoa, setting up multi-organizational interrelated O&M system with the P-CERWASS being at the core of the structure. In order to achieve the effective management, uninterrupted CD should be conducted in the three layers, individual, organizational, and institutional or social levels.

(4) Financial analysis

Financial analysis for the proposed project was carried out by using the FIRR. Result of the FIRR for overall project is -11.4%, which can be concluded that the project is financially infeasible under the designated condition in the Report. The proposed project should, therefore, be financed by grant funds to cover initial investment cost mainly for construction work. If only the initial investment cost could be secured, net income can cover the O&M costs.

As for the operation and maintenance cost, prospective profits in each projected facility is barely recoverable. In addition to the O&M expenses, depreciation and future investment costs are required

after the Project. In order to cover such costs, water charges need to be raised from the current unit price. Tariff schedule in the Report is tentatively proposed to aim financially sound management of the water supply systems and considering affordability and willingness to pay of water users in the four targeted Provinces.

(5) Environmental and social considerations

The environment impacts for water source development and system construction are minor due to small size facility and the impact will be minimized and mitigated.

(6) Sanitation Improvement Plan

Necessity of further efforts to increase sanitation coverage is identified. Needs of environmental measures are also focused, including prevention of groundwater pollution from septic tank effluent and administration for septic tank sludge disposal. Approaches toward sustainable improvement of environmental sanitation are recommended, such as establishment of provincial taskforce, enhancing IEC, dissemination of new design of urine-feces separation toilet, enhancing financial support and environmental administration.

6.2 Recommendation

(1) Water supply plan

As a study result of the alternative water source, the wide area water supply system shall be investigated and designed including surrounding communes that lack appropriate water supply system and increased future demand from technical and economical aspect.

(2) Groundwater development

As well-known, both aspects: natural and social conditions should be considered to make rural water supply plan. However, groundwater resources potential evaluation as the most important item of the natural conditions has not been studied adequately or unpublicized in Vietnam. It should be leveraged for the planning prior to selection of candidate areas or communes for rural water supply plan.

(3) Water supply management

As for Phu Yen and Khanh Hoa P-CERWASSs, it is recommended to promote restructuring of the organization so as to increase the operational efficiency. To do so, comprehensive organizational reform, by establishment of operation and management department, is highly recommended. In addition, technical assistance from the proposed advisory group and experienced Ninh Thuan and Binh Thuan P-CERWASSs is also expected to develop and monitor the management of the two inexperienced water companies.

In order to develop human resources to the desired level for sound management of water supply organizations, and to keep the workforces required for the proposed future water supply systems, both rationalization and employment of staff would be necessary. At the same time, CD of the staff would also be imperative to maintain and develop water supply management. During the Study period, CD plan has almost been conducted as per schedule. However, continuous training and education programs, in line with the proposed CD plan, are strongly recommended for all employees in P-CERWASS and other officials involved in water supply systems. In addition, IEC activities intended for CPC and its inhabitants or water users and the development of laws and regulation on water supply should also be carried forward in the wake of the above development programs.

(4) Financial

The current water charges are not high enough to cover all the operational expenses including depreciation and future investment. In many cases in the targeted project sites, it will marginally allow P-CERWASSs to break-even. Judging from the monthly expenditure per household surveyed by the Study Team, the current water charges are still cheap for water users. Thus, water charges should be increased in order to allow P-CERWASSs to generate higher fund reserve. However, this option should be carefully pondered well in advance as increase in water charges may cause decline in water charges collection. So further social and economic survey must be carried out on this issue and variables affecting water charge collection ratio must be identified.

In addition to the tariff increase, subsidies from the central and local governments and other fund sources such as international aid organizations are expected to improve the financial condition of each P-CERWASS.

(5) Sanitation Improvement Plan

In order to implement the approaches presented in the Study, foreign assistance schemes are recommended since rural sanitation contains cross-sectoral issues and institutional framework is still weak. For example; grass-roots assistance to follow up the Model Sanitation Program under the Study, technical cooperation for capacity development on environmental administration in rural area, and sludge treatment plant project by CDM are recommended.

Further technical examination on septic tank sludge treatment is recommended. As a case study, preliminary design and cost estimation on septic tank sludge treatment is carried out as ANNEX 2, which includes examination on environmental effects through the sludge treatment.

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ANNEX 1 MODEL SANITATION PROGRAM

1.1 Introduction

1.1.1 Background

Improvement of rural water supply shall be implemented together with sanitation improvement. Sanitary condition in the Study areas is serious, as coverage rate of sanitation is very low despite efforts by the Government of Vietnam.

As sanitation sector involves complex problems, such as personal hygiene, financial, technical and environmental issues, a model sanitation program is to be prepared in the course of the Study in order to address the problems in a more effective way. Under the program, sanitation education to students and sanitation facilities in the target schools are to be provided. Lessons learned in the program are to be reflected into the master plan for sanitation improvement.

1.1.2 Objectives

The model sanitation program aims to find out better approaches to improved sanitation in the Study areas, by provision of model sanitation toilet facilities and sanitation education to the target schools.
In order to achieve improved and sustainable environmental sanitation in the Study areas, the following activities are proposed, in addition to current practices of hand-washing before meals and after excretion, and increasing coverage rate of sanitation facilities:

(i) To disseminate proper function and maintenance of the dry type toilet so that people can reuse the separated urine as well as dry alkali feces in agricultural fields
(ii) To recommend an improved pour flush toilet with septic tank which separates urine from feces, considering that effluent from septic tank may cause groundwater pollution and that collected waste sludge are discharged into non-arable lands without treatment which may causes environmental pollution.
(iii) To disseminate information that human excreta contains a lot of useful nutrition that could be applied to the fields, while chemical fertilizer may cause degradation of agricultural lands, especially in areas where multiple cropping is practiced, e.g. in the Study area.
(iv) To collaborate with MOH and DOH, which takes initiatives in IEC activities on sanitation education under NTP II.

1.1.3 Sanitary Conditions in Study Area

In the beginning of the program, the Study Team assessed the current situation on sanitation in schools and residents. The results of this assessment are summarized below:

(1) School Toilets

- Number of toilets for teachers and students are not enough. In many cases, toilets are

half-collapsed and malfunctioning. Only a few toilets are working and are shared by many people in the school.

- Most of the toilets are locked so that students are not able to access it freely. In many schools, students excrete in open-air.
- Even though it is pour flush toilets, they do not have continued water supply due to empty water tank or dried-up wells.
- Although DVCL type is used in some schools, urine is directly discharged to the ground. It seems that excreta are not used for agricultural purposes.

(2) Residential Toilets

- Septic tank is constructed near shallow well within premises of a resident, which may cause groundwater pollution by nitrate contained in effluent from the tank. Few residents have accurate knowledge on it.
- In the Study area, dry type toilet was once promoted by MOH more than 20 years ago. The function and maintenance was not well understood by the residents. As a result, dry type toilets are not accepted by most of the residents. On the other hand, pour flush toilet with septic tank is believed to be clean, with low level of smell and suitable to be constructed within the house.
- Few residents pay attention to groundwater pollution caused by effluent from septic tank and environmental pollution caused by untreated wastes discharged into the agricultural fields.

1.2 Methodology of the Program

1.2.1 Procedure of the Program

(1) Flowchart

The procedure followed for implementing this program is illustrated in the Figure 1.2.1

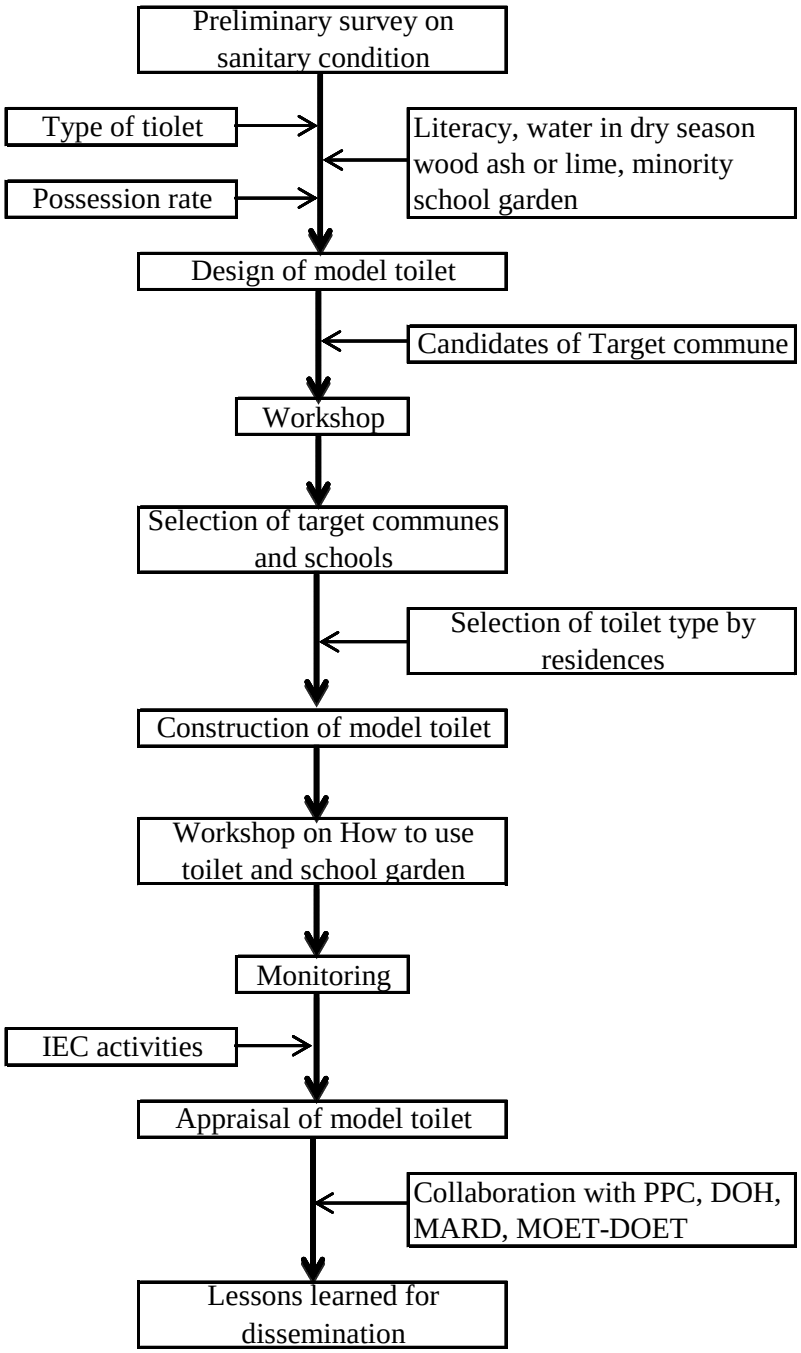
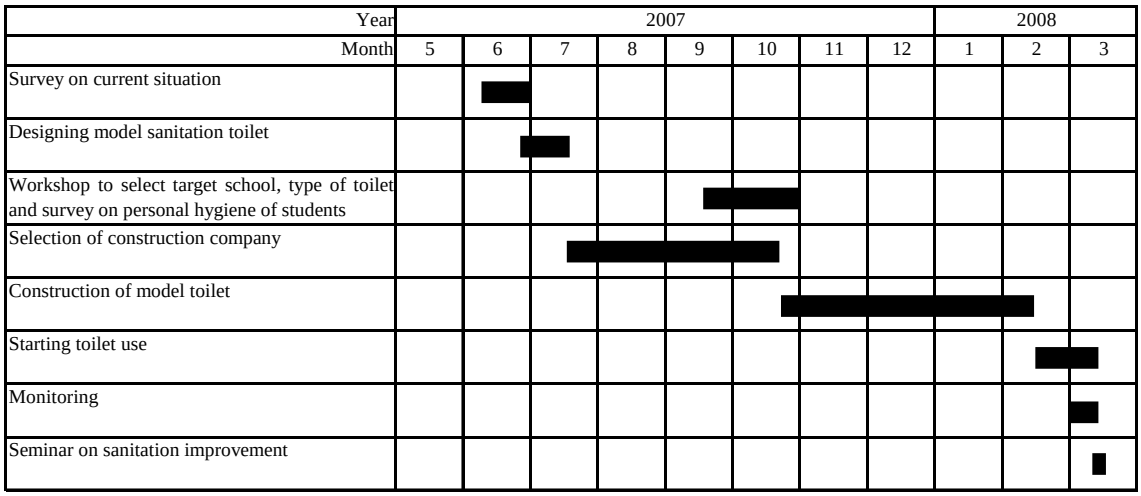


Figure 1.2.1 Implementation Flowchart of the Model Sanitation Program

(2) Implementation Schedule

The implementation schedule is shown in the Figure 1.2.2.

Phase 1: June 2007 – March 2008



Phase 2: May 2008 – February 2009

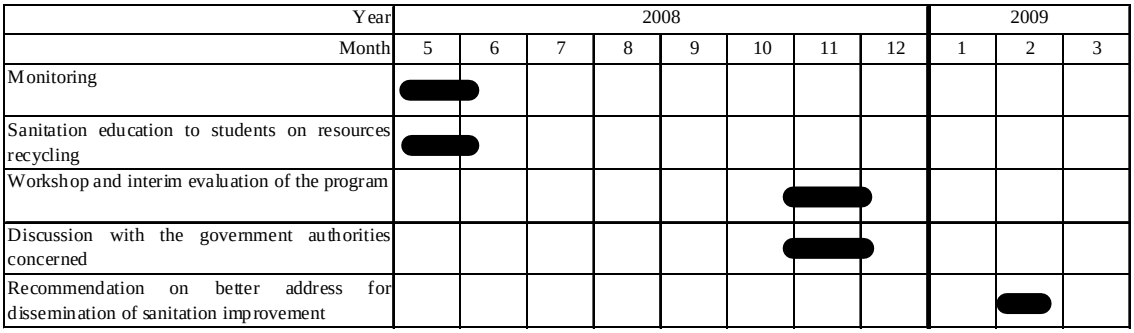


Figure 1.2.2 Implementation Schedule of the Model Sanitation Program

1.2.2 Target Communes and Schools

(1) Selection of Target Communes

Two communes from each province of the Study area were selected as candidates for the target communes considering the following criteria.

- High literacy rate for easy communication with the Study Team
- Necessity of sanitary toilet and willingness to improve sanitation condition
- Availability of water source in dry season, or availability of wood ash or lime throughout the year
- Consideration to ethnic minorities
- Understanding of the concept of resource recycling and vegetable garden in school premises
- Good accessibility by vacuum cars in case of septic tank toilet

In every commune, workshops were organized following the schedule as shown in the Table 1.2.1. Participants in the workshop included staff of P-CERWASS as the counterpart to the Study, representatives of CPC, staff of health station of the commune, representatives of schools, and representatives of residents.

Table 1.2.1 Workshop Schedule

	Item	Commune	Date
1	Selection of target communes and schools	P3 (An Tho) and P7 (Suoi Bac) in Phu Yen Province	September 26-28/2007 October 15/2007
		K1 (Cam An Bac) and K3 (Cam Hai Tay) in Khanh Hoa Province	September 20-25/2007 October 9/2007
		N1 (Nhon Hai) and N2 (Cong Hai) in Ninh Thuan Province	October 4-8/2007 October 11/2007
		B1 (Muong Man) and B4 (Tan Duc) in Binh Thuan Province	October 1-3/2007 October 18/2007
2	Selection of toilet type	P7 (Suoi Bac) in Phu Yen Province	October 16/2007
		K1 (Cam An Bac) in Khanh Hoa Province	October 10/2007
		N2 (Nhon Hai) in Ninh Thuan Province	October 12/2007
		B1 (Muong Man) in Binh Thuan Province	October 19/2007

(2) Contents of Workshop

Main contents of workshop are listed as follows:

- Presentation on sanitation education including four topics; (i) necessity to stop practice of excretion in open air, (ii) possibility of groundwater pollution by pour flush with septic tank, (iii) concept of resources recycling, and (iv) important roles of students in model sanitation program
- Explanation on water quality of effluent and infiltration from septic tank, and possibility of groundwater pollution
- Provision of sanitation education through interview to health worker and discussion on cause of waterborne disease which increases in rainy season
- Dialogue with residents about personal hygiene and sanitation
- Dissemination of accurate knowledge to residents, health workers, teachers, and representatives of CPC, that recycling human excreta into agricultural lands is sanitarily and sustainable solution in rural area
- Demonstration of model toilets to be constructed under the program, which enable improved sanitation and resources recycling under conditions that few sewerage system and night soil treatment plants exist.

(3) Selection of Type of Model Toilet

School toilets for students and teachers

Type of toilets for students and teachers is to be selected by CPC, residents and teachers through workshops. Toilets for students are composed of boys and girls, having respectively 3 rooms each for feces and space for urine. Toilet bowl for feces is to be in the marketplace. Toilets for teachers are also composed of gents' toilet having one room for feces and one urine bowl and ladies' toilet having two rooms. Toilet bowl for teachers is to be chair type bowl.

CPC, residents and teachers choose from two types of toilets; dry type toilet and pour flush with septic tank, presented by the Study Team, with consideration of the following factors:

(i) Availability of water source in dry season
(ii) Availability of wooden ash, sawdust or lime
(iii) Viability of vegetable garden in school premises, or possibility of application of composted excreta
(iv) Financial affordability of costs for sucking out sludge regularly by vacuum car

In case that pour flush with septic tank type is selected, all chambers of septic tank are to be waterproof. Effluent from urine storage tank is to be combined with wastewater of hand-washing and rainwater to flow into evapo-transpiration bed (permeating trench field). Sludge accumulated in the bottom of septic tanks is recommended to be sanitarily disposed of.

Demonstration Toilets

For demonstration purposes, three residents from each target communes are to be selected, who satisfy the following conditions:

(i) To have agricultural land
(ii) To have understandings on concept of ecological sanitation
(iii) To be willing to apply composted excreta to agricultural fields
(iv) To maintain the school toilets voluntarily

One room with chair type bowl is to be constructed / installed for each resident.

Urine-Feces Separation Type Chair Toilet

Urine-feces separation type chair toilet bowl is to be installed for teachers' and as demonstration toilets, as shown in the Figure 1.2.3. It should be underlined that this prototype is the first model introduced in Vietnam which is designed by the Study Team. As of November 2008, this type is under procedure of application to be one of the hygienic standard latrines, approved by MOH.


Dry Type


Pour Flush with Septic Tank

Figure 1.2.3 Photos of Urine-Feces Type Chair Toilet Bowl

(4) Selected Target Commune and Schools and Type of Toilets

Target communes, schools and type of toilets are selected through workshops. They are listed in the Table 1.2.2.

Table 1.2.2 List of Target Commune, Schools and Type of Toilet

Province	Target Commune	School Toilet			Demonstration Toilet
		Name of School	Type of toilet	Number of toilet bowls	Number of toilets
Phu Yen	P7 Suoi Bac	Truong Tieu Hoc primary school	dry type	Teacher:3 Pupils:6	Residents:3
		Truong Trung Hoc secondary school	dry type	Teacher:3 Pupils:6	
Khan Hoa	K1 Cam An Bac	Truong Thcs Nguyen Trai secondary school	Pour Flush with Septic Tank	Teacher:0 Pupils:6	Residents:3
Ninh Thuan	N2 Cong Hai	Truong Tieu Hoc primary school	Pour Flush with Septic Tank	Teacher:3 Pupils:6	CPC:1 Residents:2
Binh Thuan	B1 Muong Mang	Truong Tieu Hoc primary school	Pour Flush with Septic Tank	Teacher:3 Pupils:6	Residents:3

1.2.3 Improved Sanitary Toilet Recommended by the Study Team

Considering several issues in the conventional type of toilet in Vietnam, improved sanitary toilets are recommended by the Study Team. The design philosophy is presented as below:

- Two types of dry type toilet and pour flush with septic tank are to be considered.
- Both types are to be urine-feces separation type. Urine is to be diluted with wastewater of hand-washing or rain water to be stored in urine storage tank which is applied as fertilizer. Effluent from the urine storage tank is to flow into school vegetable garden.
- Toilet bowls to be installed for teachers and demonstration purposes are urine-feces separation type chair toilet which is designed by the Study Team.
- Students shall urinate in a space for urine while they excrete only feces in rooms so as to separate urine from feces. Toilet bowl for students is to be the squat type available in the market place.
- In the case of demonstration toilet to be installed in the residence, urine is to be collected in a plastic tank and diluted into 5 to 10 fold dilution for application to agricultural fields.
- Composted dry feces from dry type toilet are to be used as fertilizer or soil improvement agent.
- Waste sludge deposits in septic tank shall be regularly sucked out by vacuum car before it gets filled up.

Model toilets are designed by the Study Team to be suitable for the target communes and schools. During Phase 2, from May 2008 to February 2009, the model toilets will be monitored for usability and convenience. Through the lessons learned during monitoring, the recommendations shall be made regarding appropriate toilets of reasonable price, sanitary and ecological, and convenient to use.

1.2.4 Sanitation Education on Resources Recycling

(1) Objects to Educate

On recognition that hygiene education are performed by DOH through communal health station to residents and included in school curriculum by MOET, most of rural people are assumed to have principal knowledge on hygiene to some extent. Also some problems were observed through the field survey with regard to structure and usage of the existing toilets. Therefore, target groups to be educated are proposed to include: students, representatives of CPC, health worker, teachers, and residents of the commune. The IEC activities shall be performed in collaboration with MOH, DOH and DOET.

(2) Resources Recycling

From the viewpoint of material circulation, it is clear that recycling of nitrogen, phosphorus and potassium contained in human excreta into agricultural field is the most effective. Nutrient composition of urine and feces are tabulated in the Table 1.2.3.

Table 1.2.3 The Nutrient Composition of Urine and Feces

	Urine		Feces		Total	
unit	g/cap/day	%	g/cap/day	%	g/cap/day	%
Nitrogen	11.0	88	1.5	12	12.5	100
Phosphorus	1.0	67	0.5	33	1.5	100
Potassium	2.5	71	1.0	29	3.5	100

Source: “A Proposal of Advanced Sanitation System and Attempts to Improve Vietnam Sanitation”, Hidenori Harada, 2007

Urine and feces are different in nutrient components. The three major nutrients of nitrogen, phosphorus and potassium are contained more in urine rather than in feces. Out of total amount of nutrient in urine and faces, urine contains 88% of nitrogen, 67% of phosphorus and 71% of potassium. Urine from healthy human is clean and does not include pathogenic bacteria. On the other hand, human feces contain undigested dietary fiber as main composition, and a lot of enterobacteria, protozoa, roundworms and ova-parasites.

Utilization of human excreta as the organic fertilizer, by means of separating urine to be diluted and feces to be composted, can reduce use of chemical fertilizer and return organic composition to the fields which revitalizes the degraded lands. It also enables the sustainable use of limited resources of phosphorus.

At present, there are no sewage or night soil treatment plants in the study area. Accumulated sludge in septic tanks are collected by vacuum trucks and discharged into the non-arable lands without treatment, which causes nitrate pollution to groundwater and other environmental problems. This situation can be mitigated by recycling urine to agricultural uses which contains 88% of nitrogen in total human wastes.

Trial Calculation on Value of Urine as Fertilizer

Value of recycled urine as fertilizer is estimated for a trial case of production from a school with 500 students.

Main assumptions are as follows:

- Number of students: 500 students
- Number of days going to school: 250 days per year
- Period staying in school: 8 hours (one third of a day)
- Price of fertilizer to compare: Prices in Vietnamese market (November 2008) are employed for trial calculation; ammonium sulfate for nitrogen, superphosphate of lime for phosphorus, and potassium chloride for potassium.

Table 1.2.4 Trial Calculation of Value of Urine as Fertilizer

	Amount of Nutrient in Urine (Kg/year)	Unit Price (USD/kg)	Amount (USD/year)	Remarks
Nitrogen	458.3	2.24	1,026.6	Pupils:500 School day:250/year Detention time in school: one third a day
Phosphorus	41.7	1.31	54.6	
Potassium	104.2	1.52	158.4	
Total			1,239.6	

As a result, recycling use of urine in the school values approximately USD 1,200 per year. The value would increase if other benefits are taken into account, e.g., prevention of land degradation and groundwater pollution.

1.3 Monitoring

1.3.1 Monitoring Items

The monitoring items are proposed from the viewpoints of usability and maintenance of the model toilets. The items to be monitored are as follows:

- Defects in usability (any problems from sanitary point of view)
- Ancillary conditions: water for hand-washing, flushing water, wood ash, lime, toilet paper, etc.
- Popularity of model toilet (cleanness, smell, emergence of mosquitoes and flies, etc.)
- Popularity of vegetable garden and growth of products
- Recycling use of human excreta in demonstration toilets
- Frequency of toilet usage by students
- How to clean the school toilet
- Provision of toilet paper, soap in school toilet
- Changes in cases of waterborne disease
- Interest in resources recycling by students and residents

1.3.2 Monitoring Method

(1) Monthly Monitoring by Check Sheet

The model toilets were monitored by using monitoring check sheet which was prepared by the Study Team. The monitoring was carried out twice a month by the staff of P-CERWASS from March 2008 until February 2009. Each monitoring item was rated by scoring.

(2) Carte of toilet

In addition to the above monitoring check sheet, carte of toilet was prepared, which includes basic information and observation record by the expert of the Team.

(3) Questionnaire Survey to Users

To supplement information, questionnaire survey was carried out in February 2009. The questionnaire sheet was distributed to the representative of the school or demonstration toilets. Also questionnaire for students are distributed to one class of each target school.

1.3.3 Monitoring Result

The results are incorporated into the “Follow Up Report”.

1.4 Lessons Learned

1.4.1 Introduction

Lessons learned are obtained through the Program. These are summarized in terms of the following six viewpoints.

1) Awareness of N-CERWASS and P-CERWASS in sanitation promotion
2) Roles and responsibilities of N-CERWASS, P-CERWASS and local authorities
3) Measures for raising public awareness on rural water and sanitation
4) Evaluation on new urine-feces separation type toilets
5) Proper maintenance and dissemination of sanitation facility
6) Proper knowledge dissemination on sanitation in community

1.4.2 Findings and Lessons Learned

(1) Awareness of N-CERWASS and P-CERWASS in sanitation promotion

Findings

- Although N-CERWASS and P-CERWASS is assigned as the official implementing agency to improve rural water supply and sanitation, none of N-/P-CERWASS in the study area has special section in charge of sanitation promotion. There is also few staff of N-/P-CERWASS who received professional education/ training for sanitation. Design standards and technical guidelines related to rural sanitation are provided under responsibility of Ministry of Health.
- Instead of sanitation section, N-CERWASS has IEC section as IEC is recognized as essential factor

for sanitation promotion. The IEC section produces IEC materials to instruct toilet construction and public relations magazines. The IEC activities have been supported by WES (Water, Environment and Sanitation) program by UNICEF since year 2001. However, IEC materials prepared by N-CERWASS don't seem to be fully utilized in provincial level, as these materials can be seen only in office of N-CERWASS.

- Although importance of IEC is well understood, there is no IEC section in P-CERWASS of the Study Area. A few staff is assigned for IEC as their additional task without clear job description in most cases. The model sanitation program was implemented through collaboration with P-CERWASS. However, participation of some staff was not active enough so that only a few staff showed good attitude to learn from the expert of the Team.
- Mobilization of staff is also a difficult issue, considering that there are approx. 300,000 households without hygienic latrines in the four provinces (estimated by the Team). Then, P-CERWASS performs IEC through collaboration with local residents group such as women's union, farmers' union, youth union, etc. But due to budget constraint, these activities are not done regularly and systematically.
- There are some cases that P-CERWASS constructs school toilets in collaboration with DOET by using budget of NTP II and some contribution by commune. According to information by Khanh Hoa P-CERWASS, the case of Dien Tan Commune in 2008, good educational effects were found by demonstrating actual toilet, which gives more impact than paper-based IEC materials. This experience seems a successful example of collaboration by taking advantage of P-CERWASS who has better experience in construction.
- As the counterpart organization, N-/P-CERWASS has become aware of environmental issues that are pointed out by the Study Team, e.g. groundwater pollution by septic tank effluent, environmental degradation by disposing untreated sludge.

Lessons Learned

- IEC in provincial level should be more activated, by using IEC materials of N-CERWASS, banners, slogans, etc. P-CERWASS also should utilize local residents groups, e.g. women's union, etc in order to improve delivery of information.
- IEC specialist should be developed in P-CERWASS, who works on planning IEC strategy, annual action planning, budget planning, monitoring of activities, etc. The staff must be given clear job description and appropriate evaluation to the job, otherwise his/her satisfaction to job becomes low which leads to reluctant working attitude. Any incentive system also should be considered. Budget allocation on IEC should be increased accordingly.
- As succeeded in a commune in Khanh Hoa, collaboration cases should be more duplicated by using strength of each organization
- The problem consciousness on environment caused by septic tank, etc. is shared with N-/P-CERWASS through the Study. Although any practical actions have been taken yet, the discussion should be developed further, since the environmental issues are not commonly recognized

among the parties related to rural sanitation.

(2) Roles and responsibilities of N-CERWASS, P-CERWASS and local authorities

Findings

- According to decentralization policy, the provincial government (PPC) executes budgets in provincial level, whereas the central government monitors and evaluates (M&E) the activity according to the M&E system. In the course of the Study, it was often seen that information sharing between central and provincial governments is not done well due to poor communication among the parties concerned.
- Cooperation and information sharing for sanitation promotion is not done well in provincial level, among DARD (including P-CERWASS), DOH and DOET. They are working on their duty according to the mandates given by the central and provincial government, and there isn't coordinating function between the related organization in regular basis. As a result, understandings on the target program on rural water and sanitation seem still low in the provincial level.
- As the status of P-CERWASS is an organization under DARD, it is regarded as the lower authority by the Department of PPC. Therefore, despite of their responsibility, P-CERWASS is not granted with enough power to deal with the upper authorities. It is also difficult for P-CERWASS to coordinate the different sectors under the bureaucratic system. In that case, P-CERWASS request to DARD for coordination. However, it seems that DARD have few interest in sanitation promotion.
- There is clinic and health worker in every commune under DOH. Public health campaign is carried out by using this local network. Also groups of residents exist commonly in every commune, such as farmers' union, women's union, youth union, etc. They are already established and have good link with CPC and local residents. In the model sanitation program, neither health workers nor residents groups were not used. However, the team organized a workshop in Suoi Bac commune to present the progress of the program and discuss about possibility of collaboration in future phase. At that time, the participants show very positive interest which is an essential factor to be local motivators.

Lessons Learned

- Monitoring on sanitation activity by provincial government should be systematically done by the central government. In implementing any projects, communication system should be clearly confirmed among the parties concerned.
- Cooperation and information sharing should be developed in provincial level, by means of coordination meeting, e.g. taskforce meeting at regular basis.
- When coordination with provincial departments is necessary, DARD should be more involved for smooth implementation.
- In IEC and public campaign, existing network of DOH in collaboration with residents groups should be utilized to link from provincial to individual levels. They could be potential motivators for sanitation promotion.

(3) Measures for raising public awareness on rural water and sanitation

Findings

- According to the socio-economic survey carried out by the Study Team, approx. 81% of respondents who don't have toilet (approx. 60% of total respondents) wants sanitary toilet. However, the rest 19% answered not so much needed. Such people sometime think that open defecation doesn't cause any hygienic problem since the premises are wide enough. Also some people are familiar with open defecation and feel comfortable.
- The type of toilet is mostly chosen as the pour flush with septic tank latrine for its cleanliness and comfort. However, people often overlook necessity of water supply as well as cost of emptying septic tank. Also, most of them are not aware of risk of groundwater pollution caused by effluent from septic tank.
- Many rural people who don't have toilets explain financial reason foremost, although many of them have other items, such as television and mobile phone.
- In the southern Vietnam, human wastes are not used as fertilizer from their cultural background, whereas they have been used in north. Resisting mind against DVCL prevails from failure of the past campaign project by MOH, which attempted to disseminate DVCL. Although details are not clear, it is said that when DVCL was disseminated in some communes, sufficient technical guidance on maintenance was not provided. And the quality of construction is poor and shabby, it became dirty soon. Then, people cannot maintain properly and quit using as becoming dirty.

Lessons Learned

- Although high demand exist, still more awareness campaign to create demand is needed for whom don't feel necessity of toilet.
- Rural people should be provided with a variety of technical options to choose the suitable toilet type in the affordable cost.
- In parallel with the above public awareness campaign, which is mainly focusing on hygienic and technical issues, information on financial support should be provided.
- Successful experience of introducing the new type of urine-feces separation toilet in the Model Sanitation Program should be widely disseminated.

(4) Evaluation on new urine-feces separation type toilets

Toilet Evaluation

According to the observation by the Team as well as the monitoring result as described in Chapter 3, the current status on the model toilet is evaluated as Table 1.4.1.

Table 1.4.1 Toilet Evaluation on Usage

Item		Criteria	School				Demonstration		
			Teacher		Student				
			DVCL	Septic Tank	DVCL	Septic Tank	DVCL	Septic Tank	
		Stool type	Chair	Chair	Squat	Squat	Chair	Char	
		No. of toilet	2	2	2	3	4	9	
Cleanliness	A	Very clean		1		1	1	8	A
	B	Clean		1	2	2	3	1	B
	C	Acceptable	2						C
	D	Dirty							D
Frequency of cleaning practice	A	Enough		1		2	4	7	A
	B	Somehow enough	1	1	1	1		2	B
	C	Not enough	1		1				C
	D	Not done							D
Flies and mosquitoes	A	No		1		2	3	8	A
	B	A few	2	1	2	1	1	1	B
	C	Some							C
	D	Many							D
Bad smell (Dry season)	A	No	1	2		2	2	7	A
	B	Some	1		2	1	2	2	B
	C	Often							C
	D	Too bad							D
Bad smell (Rainy season)	A	No		2		2	1	7	A
	B	Some	1		1	1	2	2	B
	C	Often	1		1		1		C
	D	Too bad							D
User's feeling on comfort	A	Very comfortable		2			1	7	A
	B	Good	1		1	1	1	1	B
	C	Acceptable	1		1	2	2		C
	D	Not comfortable						1	D
User's wish to refurbish	A	No (as it is)	1	2			2	9	A
	B	Somehow no							B
	C	Somehow yes							C
	D	Yes (want change)	1				2		D
Separating urine from feces	A	Done properly	2	2			3	9	A
	B	Done somehow							B
	C	Not done well			1	1	1		C
	D	Not done at all			1	2			D
Fertilization	A	Done properly		1		2	1		A
	B	Done somehow						3	B
	C	Not done well					1	3	C
	D	Not done at all	2	1	2	1	2	3	D
Users' interest in fertilizing	A	Very much		1		2	1		A
	B	Somehow						3	B
	C	Not much					1	3	C
	D	Not at all	2	1	2	1	2	3	D

Findings

- Cleanliness: Both of the DVCL toilets for teachers in Phu Yen are not so clean. According to teachers, they have a resistance to clean feces hole of the chair type dry toilet stool, when they find a kind of scum of anybody else. And the hole is not allow water use even for cleaning, it is more difficult. Some teachers don't want to sit on the dirty stool, then use the squat type for students. Otherwise, teachers go back home, instead of using school toilet. However, situation is different if it

is personal use, like demonstration toilet. Even though water is not allowed, the family keep toilet clean as they don't feel like scum of others when cleaning. For flush toilet, all toilets are generally kept clean, regardless of toilet types, public and domestic use. Also cleanliness is related closely to practice of cleaning, according to the table.

- Flies and Mosquitoes: Only a few flies are found in some toilets. But generally no flies are seen.
- Bad smell: Due to rainwater intrusion in dry toilets in Phu Yen province, bad smell was generated which became the cause of dislike to DVCL by users. However, in dry season, no bad smell is felt, that implies bad smell can be prevented even in rainy season if water tightness of feces vault can be secured. Effect of ventilation pipe and roof fan is an influential factor.
- User's feeling on comfort: The chair type urine-feces separation toilet stool is designed to be friendly to aged and handicapped people. Most users answered using comfortably. The users who experienced bad smell of DVCL caused by rainwater intrusion answered acceptable or not really comfortable. The rating of septic tank toilet for students is not high, because not a small number answered to the questionnaire survey as "not so convenient". It is assumed that they feels difficulty in urinate before feces, taking into account that considerable number of students answered to choose urine-feces separation type toilet for their house. One resident in Ninh Thuan don't use toilet, because of his concern that effluent from septic tank flows to the neighbors premises. Three out of 6 users of DVCL wants to refurbish it into septic tank toilet. But it is assumed that incident of rainwater intrusion affects to this result.
- Practice of urine-feces separation: Users of chair type stool can separate easily owing to the mechanism of toilet stool in nature. But the students feel difficulty in separating urine before defecation.
- Fertilization: Only three users are fertilizing properly. It largely depends on user's interest and understanding. People having interest show positive attitude of using the urine and composted feces as fertilizer to grow and harvest crops. If users don't have interest, fertilization is never done and urine is collected but just disposed. Some users don't follow the instruction of dilution.

Lessons Learned

- For public use, such as school toilet, chair type dry toilet stool is not applicable because of difficulty in cleaning. In this case, squat type DVCL toilet base is applicable, which has urine hole as well. For domestic use, chair type dry toilet stool is applicable since cleaning is not really difficult. As for the septic tank toilet, urine-feces separation toilet stool is applicable both for public and domestic purpose.
- Flies and mosquitoes are not found a lot, which are ones of prime reason of dislike of DVCL. Difference between DVCL and septic tank wasn't observed. Bad smells are also not felt under condition of proper using. In case of DVCL, water-tightness shall be secured with care. Ventilation should also be paid attention to.
- The chair type urine-feces separation toilet stool is possibly accepted by rural people. Especially pour flush with septic tank type is favored by most people, both of public use and domestic use. For

dry toilet stool, it could be applicable for domestic use only.

- Practice of fertilizing is not done as expected. People don't fertilize if they don't have interest and understand. Even though they have interest, some people don't dilute as instructed for troublesome job of dilution and conveying. Although fertilizing is not understood well within the time frame of the Program, the effects of urine fertilization were confirmed through the success in school garden of Cam An Bac and Muong Man Schools, where a variety of crops are grown by urine fertilizer and harvested periodically under good practice of the schools. Taking into account that good practice is done by persons who have an interest in fertilizing and maintain properly, rural people could convince the effects if they can see for themselves the actual farm and products grown by urine fertilization. In this regard, sanitation promotion would be effective if it is performed in collaboration with instructors of agriculture under DARD and/or leaders of farmers union, who can demonstrate the good practice and motivate the people.

(5) Proper maintenance and dissemination of sanitation facility

Toilet Evaluation

The current status on the model toilet related to maintenance is evaluated as Table 1.4.2.

Table 1.4.2 Toilet Evaluation on Maintenance

Item		Criteria	School				Demonstration		
			Teacher		Student				
			DVCL	Septic Tank	DVCL	Septic Tank	DVCL	Septic Tank	
		Stool type	Chair	Chair	Squat	Squat	Chair	Char	
		No. of toilet	2	2	2	3	4	9	
Provision of water or wooden ash	A	Always ready		2		3	4	9	A
	B	Sometime lack	2		2				B
	C	Often lack							C
	D	Not ready							D
Provision of paper and soap	A	Always ready				1	3	9	A
	B	Sometime lack	1	1	1	2	1		B
	C	Often lack	1	1	1				C
	D	Not ready							D
Treatment of septic tank sludge or dry feces	A	Done properly					1		A
	B	Done somehow	1				1	3	B
	C	Not done well	1	2	2	3	2	3	C
	D	Not done at all						3	D

Findings

- Provision of water or wooden ash: Collection of wooden ash was an issue raised in the school toilet of Phu Yen province. In this case, both two schools are helped by students to bring ash from home. In a school of Ninh Thuan, toilet was not used for about 9 months after commissioning, because of lack of water. It took 8 months for them to receive the budget for installing motor pump and tank from the DOET.
- Provision of paper and soap: In case of school, it depends on policy of school, either school provides or student shall provide.

- Treatment of septic tank sludge: There is big consciousness gap between rural people and the Team, in terms of necessity of emptying septic tank as it is widely believed in Vietnam as a commonsense that the tank can be sucked out only after 5-10 years, while the Team suggested every 6 months – one year in order to prevent pollution by septic tank effluent. One user installed soak-pit after the effluent pipe. And another one extend the effluent pipe to the field. Both practices are done by wrong knowledge. Also the cost for vacuum car of approx. VND 500,000 seems unaffordable for common rural people as well as school which is dependent on budget from DOET.

Lessons Learned

- In planning toilet, necessary requirements should be considered carefully, such as availability of wooden ash (or lime) for dry toilet and water supply facility and sucking out by vacuum cars for septic tank toilet.
- Way of provision of paper and soap should be confirmed before construction.
- Peoples awareness on treatment of septic tank sludge seems difficult to change, unless large-scale campaign would be taken place. In this case, enforcement policy lead by the central government could be effective.

(6) Proper knowledge dissemination on sanitation in community

Findings

- Under the governance system of Vietnam, any activity in commune should be performed through consent of CPC. Access to any organizations in commune, such as school, residents groups, etc. is easy by cooperation of CPC. Mobilization of people also can be done by CPC. And workshop was held in the hall of CPC. In this case, however, CPC is so influential that discussion is often subject to CPC's opinion. Whereas the governance system works well, it could be obstacle to spontaneous activities of rural people. In the program, decision making was done by CPC in most cases, such as selecting toilet type and nominees of demonstration toilet.
- Sanitation education was provided by the Team in the target schools. Since the class was held limited to one class of each target commune due to time constraints, the remarkable effects were not seen. It seems that sanitation class was more accepted by primary school than secondary school. Higher grade students seem to have preconception and tend to show shame of talking about human wastes.
- Visual educational materials were used for sanitation education and workshop which can help to reduce language barriers and understand some technical subject. It is also suggested from the experience of P-CERWASS Khanh Hoa that provision of real toilet for demonstration purpose, like the model toilet under the program, can be more convincing rural people rather than virtual image and information. In fact, the Team received a lot of reaction and feedback by displaying the real model of urine-feces separation toilet stool on occasions of workshop and seminar.
- Demonstration effect by the user of model toilet was not seen as anticipated. The users are not aware well of their role of advertizing the model toilet because they were not clearly told by the Team.

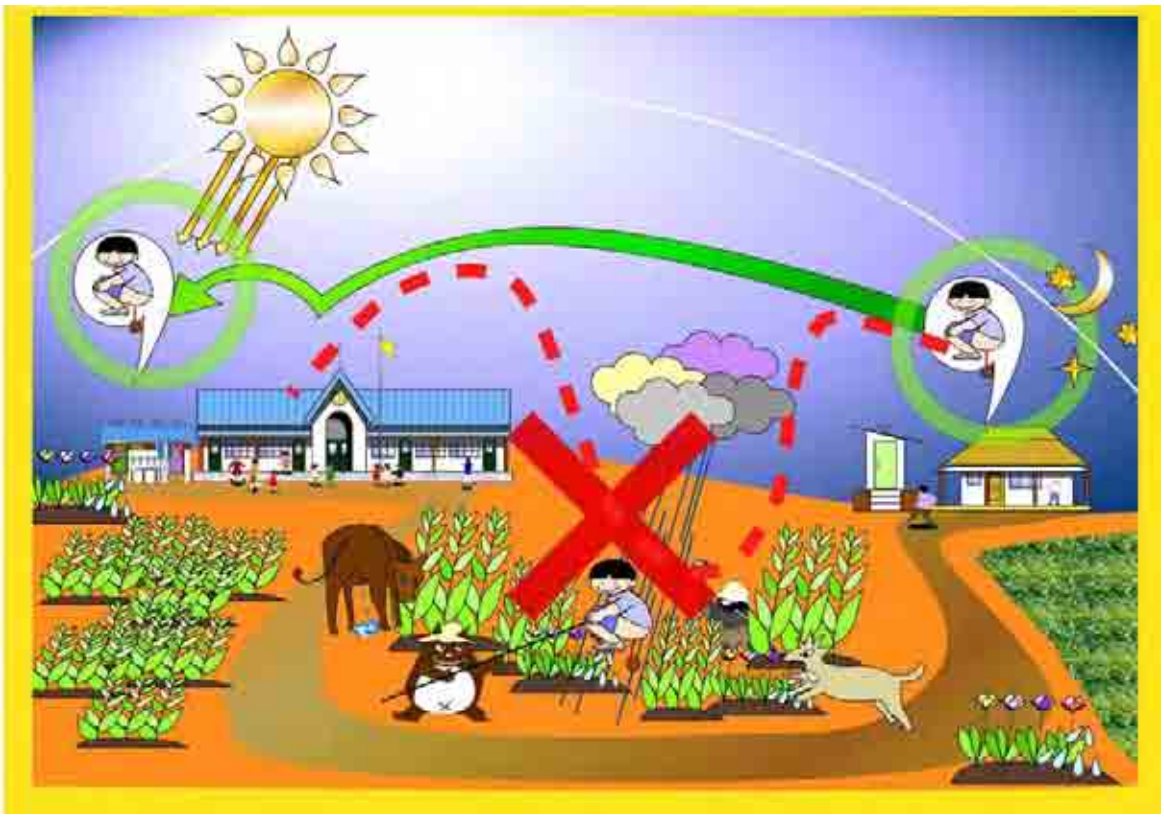
Another factor is assumed that some users were chosen by CPC regardless of their interest in sanitation promotion, although the Team explained one objective of the program is to disseminate sanitation toilet through demonstration, and requested to choose good motivators to the other people.

- As a whole, intervention to rural people by the Team was given for short period and information was given in one-way due to time constraints, whereas transferring proper knowledge requires long time and face-to-face dialogues. As a result, the effect of knowledge transfer depends largely on the base knowledge of the recipients.

Lessons Learned

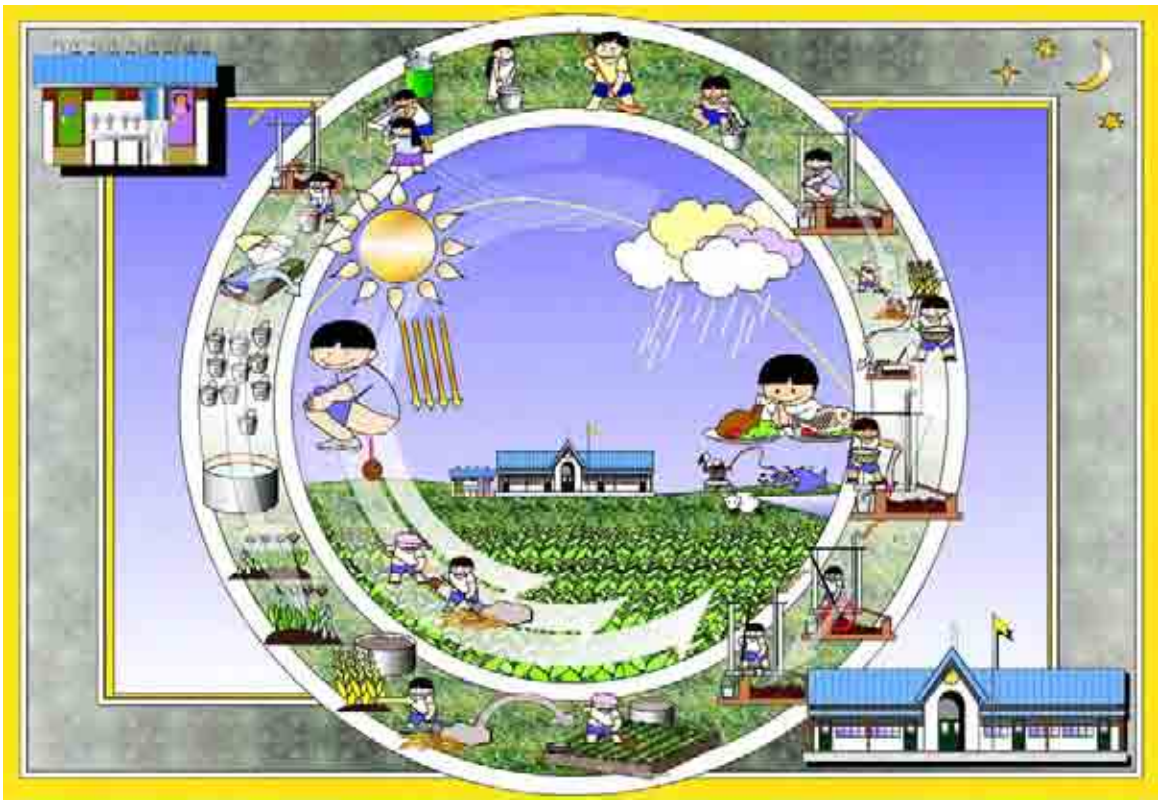
- Whenever intervention from outside commune is carried out, consensus and cooperation of CPC is necessary. Although involvement of CPC is important, some mechanism of participatory process should be taken into account in discussion and decision making.
- In sanitation education in school curriculum should be started from lower grades for better effects.
- Visual materials are effective for better understanding by rural people. Also displaying and demonstrating real model would be more convincing than virtual information given by papers and images.
- Local motivators, who can influence and motivate people by using their grass-roots networks, should be developed in order to promote effectively. In this case, it is envisaged that the local motivators can be found in the residential groups, such as women's union and farmers' union as they are established organization already in the commune and able to mobilize the group easily.

1.5 Poster for Sanitation Education

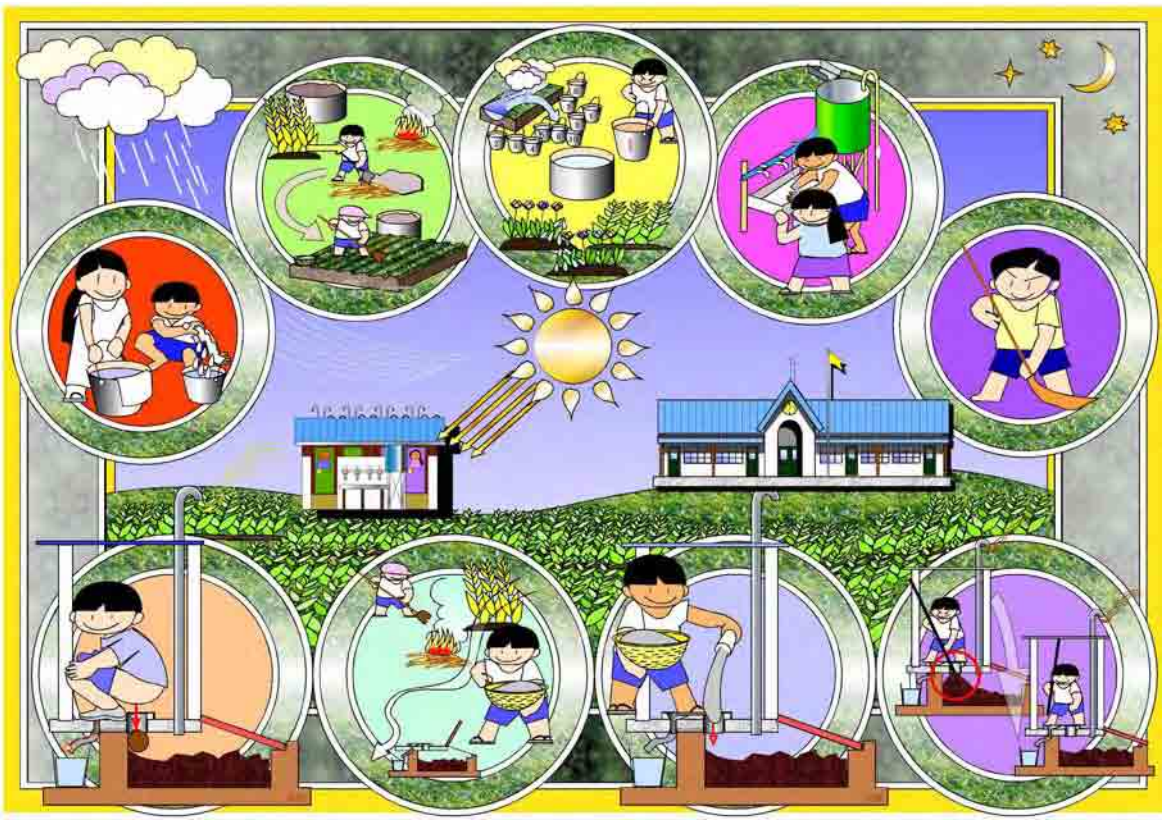


Prohibition of Open Defecation

Risk of Groundwater Pollution by Septic Tank Effluent

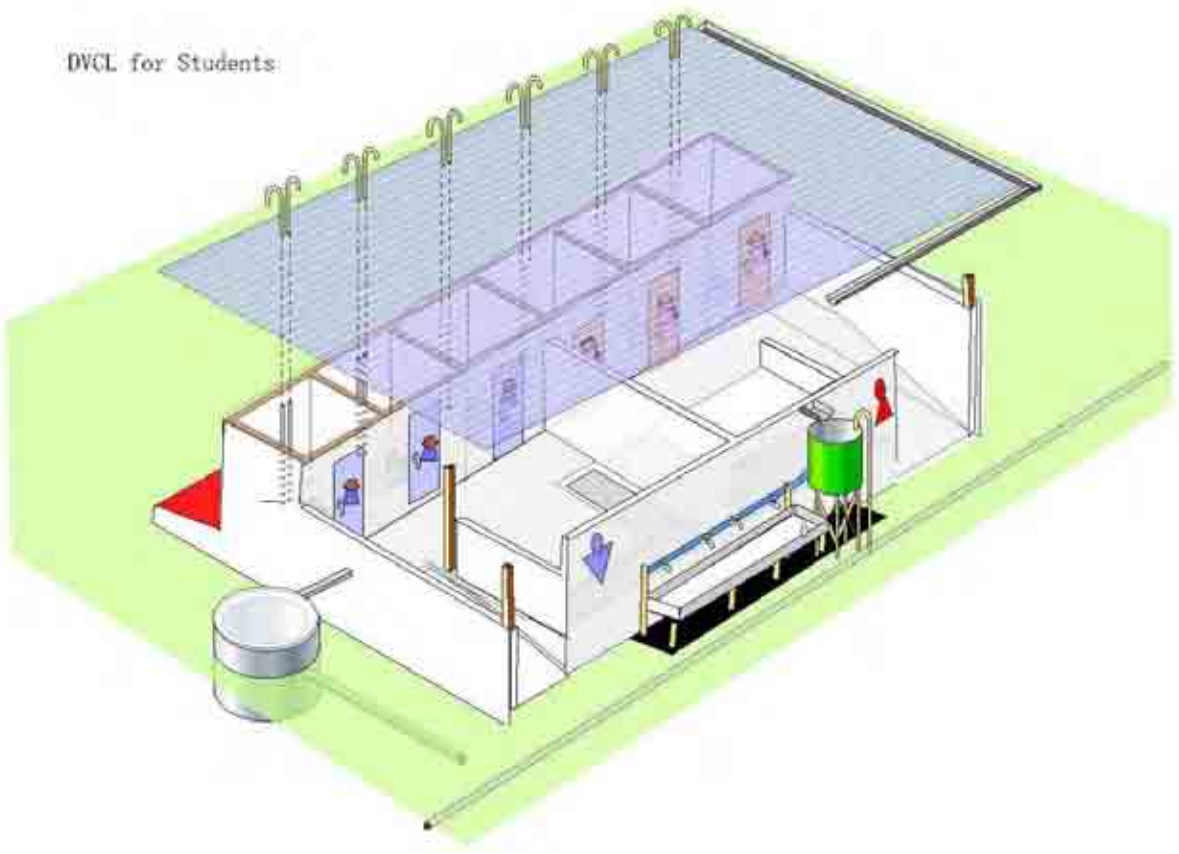


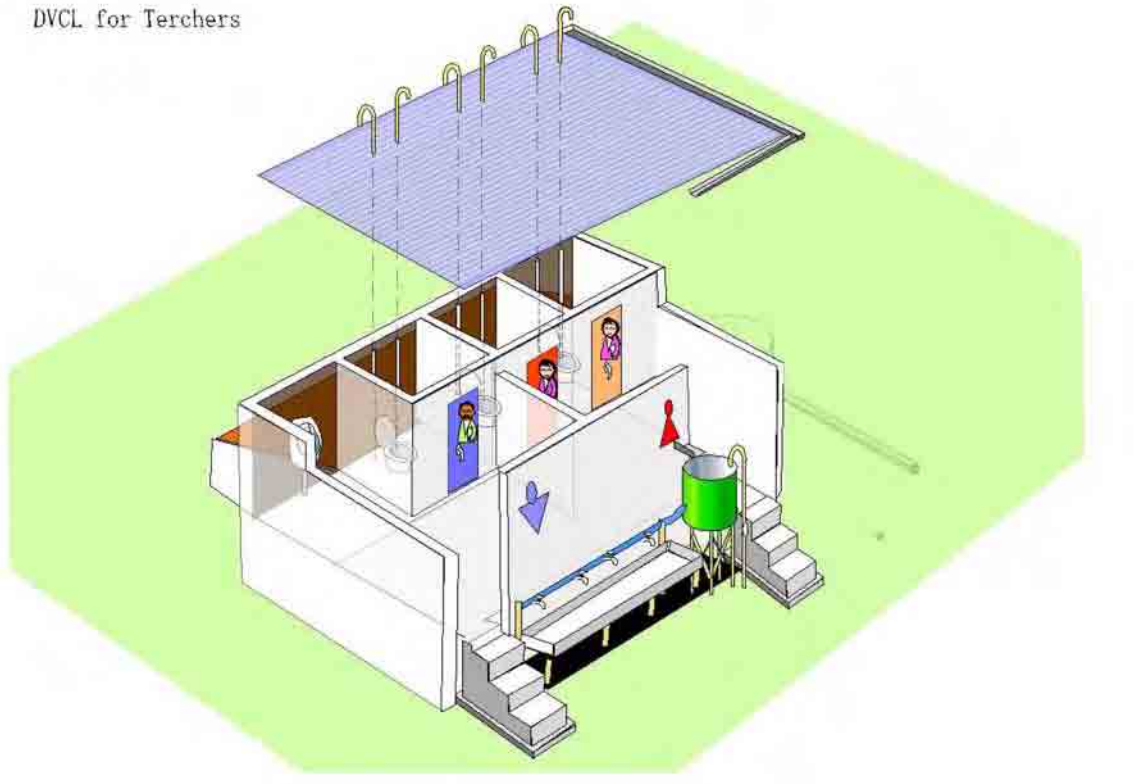
Concept of Resources Recycling through School Toilet and Garden



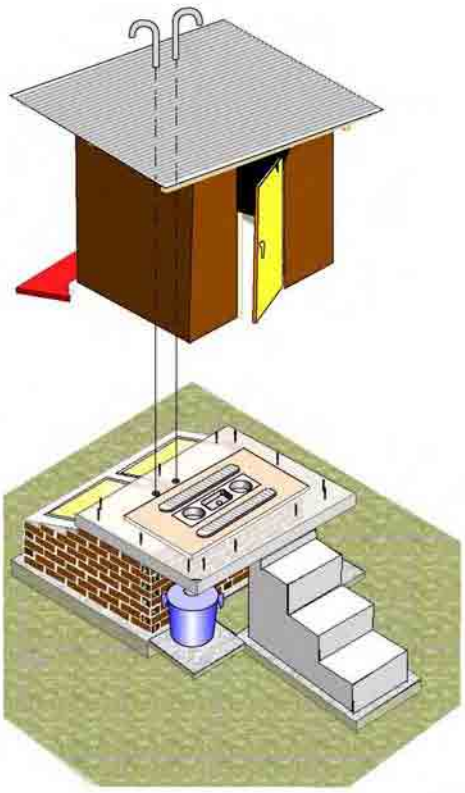
How to Maintain School Toilet and Garden

1.6 Conceptual Drawings of Model Toilets

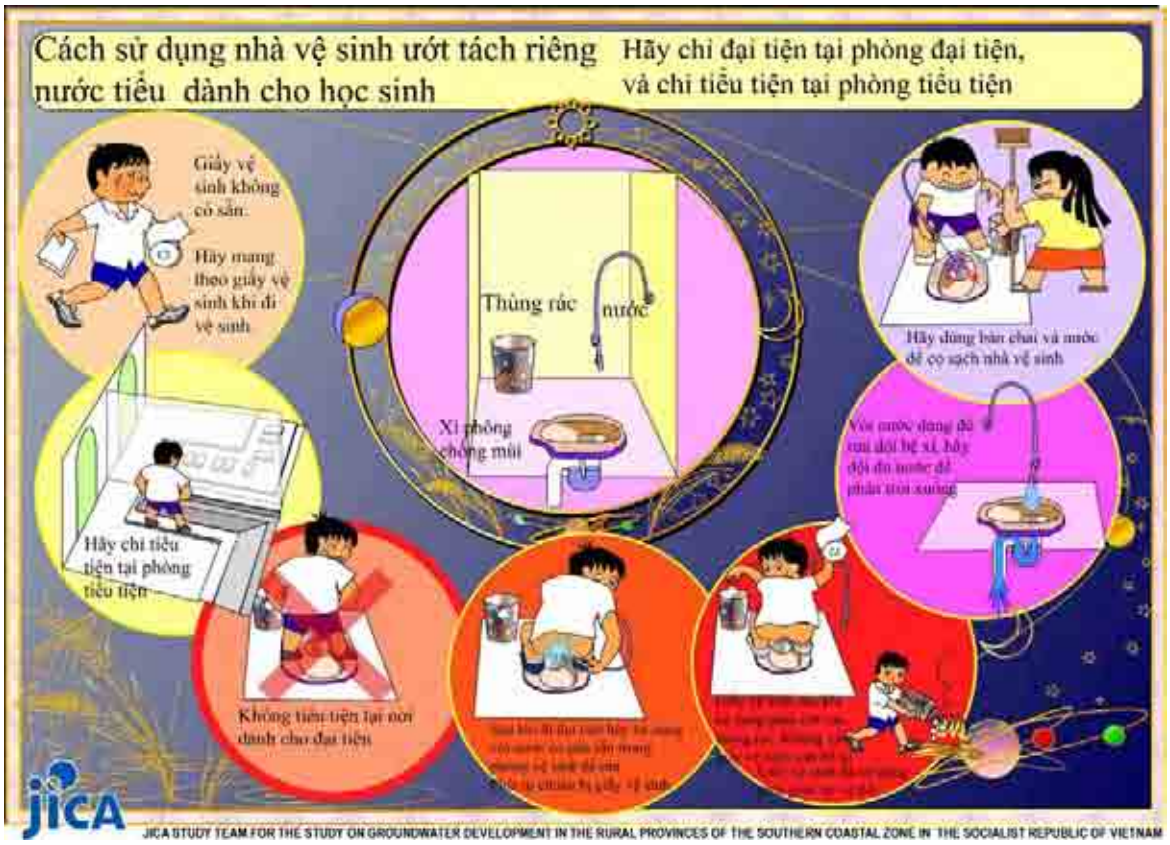




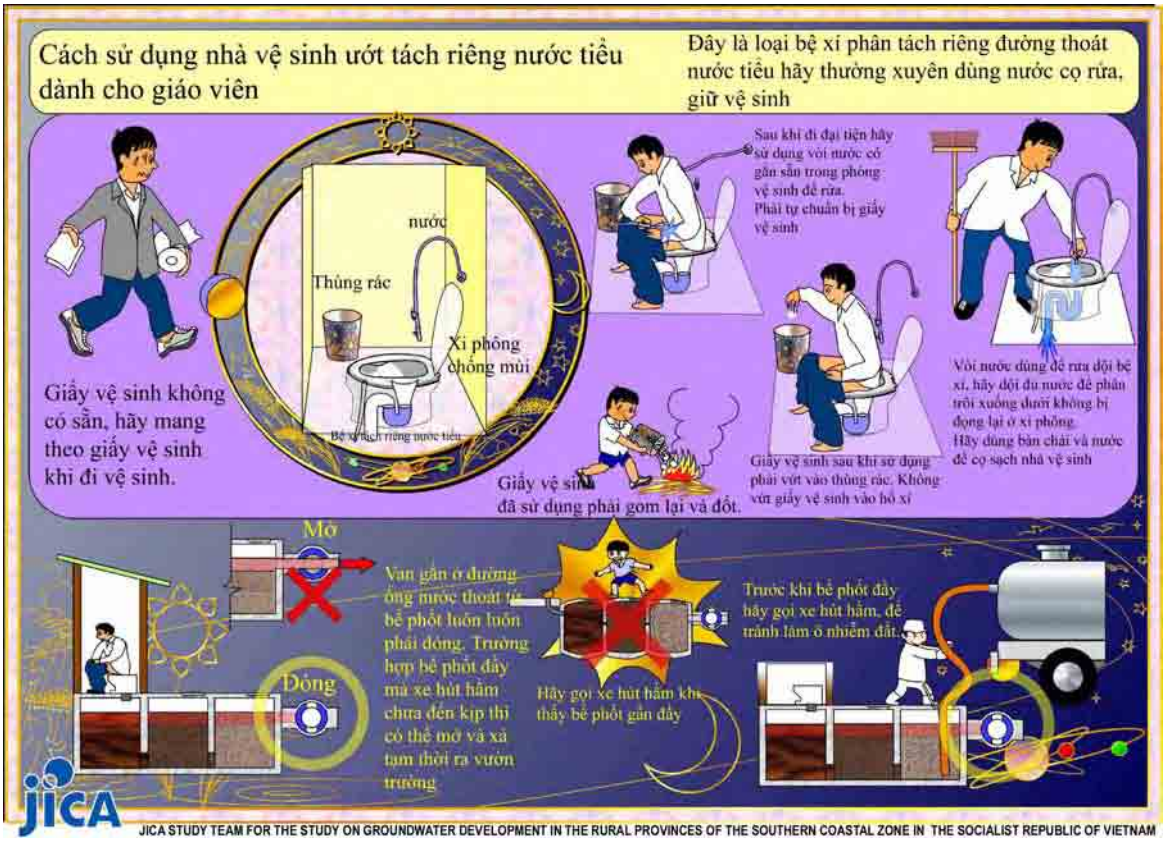
DVCL for Residences



1.7 Instruction How to Use Toilet



How to Use School Toilet for Students (Septic Tank)



How to Use Toilet for Teachers & Demonstration (Septic Tank)

How to Use School Toilet for Students (Dry Toilet)

Instruction for How to Use Toilet for Teachers & Demonstration (Dry Toilet)

Application of Urine Fertilizer which is Diluted with Hand-washing Water and Rain Water and Flows by Gravity to the School Garden

1.8 Water Quality Analysis for Existing Septic Tank

Water Quality Analysis for Septic Tank

Water quality analysis was carried out for effluent and sediments of the existing septic tank toilets, sampled from Cam An Bac (K1) commune. The parameters are; fecal coliform, BOD, COD, Total suspended solid and Total Nitrogen. The results are shown in table below:

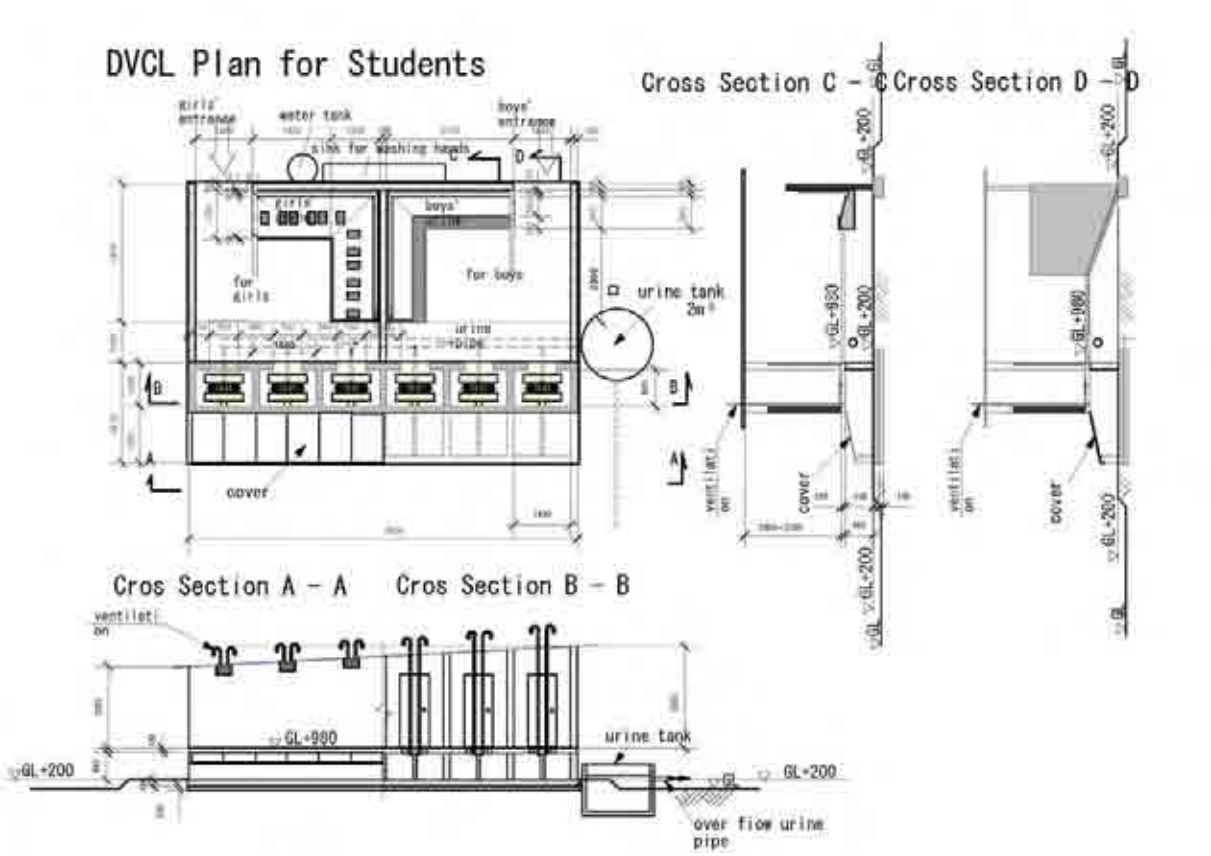
Water Quality Analysis Results

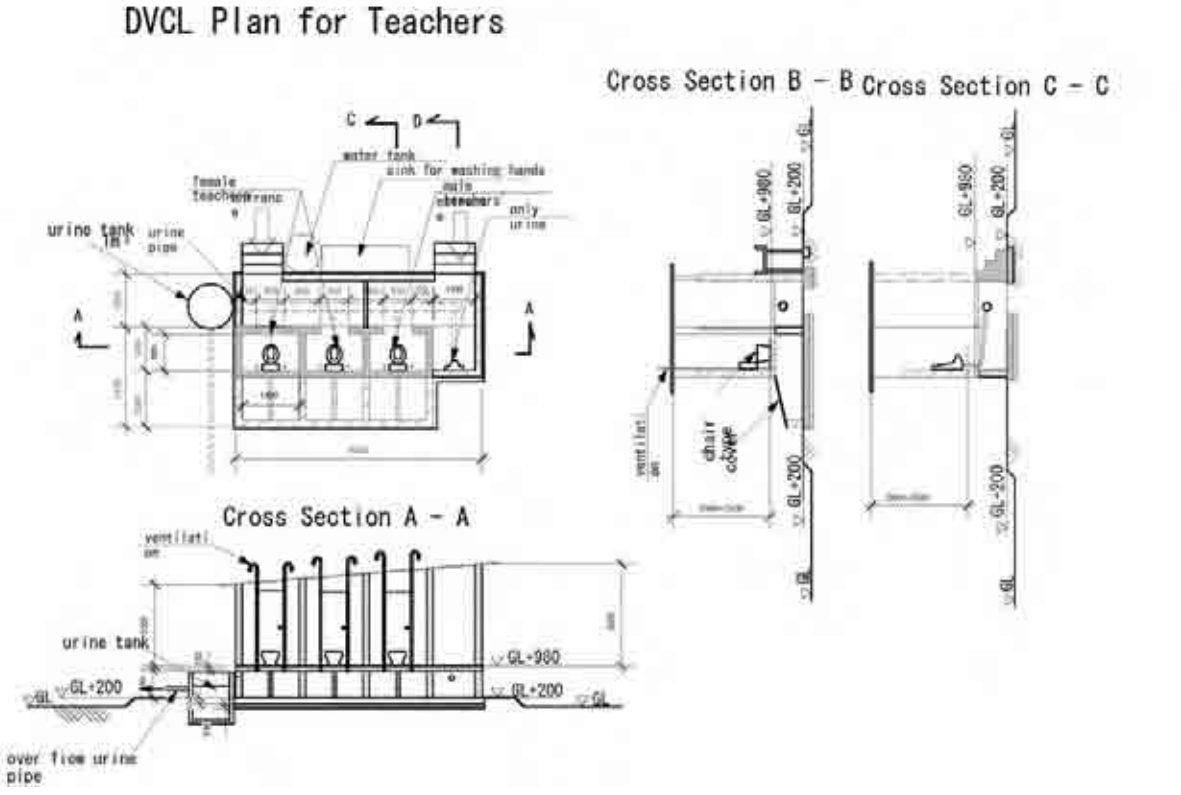
Place	Sampling Point[#1]	Fecal Coliform (MPN/100mL)	BOD (mg/L)	COD (mg/L)	Total-SS (mg/L)	Total-N (mg/L)
K1 Secondary School	Effluent	$21{,}000 \times 10^4$	691	965	326	795
	Sediments	930×10^4	1,387	1,900	2,371	829
Household-1	Effluent	15×10^4	717	969	52	227
	Sediments	93×10^4	725	897	227	240
Household-2	Effluent	7.5×10^4	240	350	65	86
	Sediments	24×10^4	398	510	45	90
Domestic Wastewater Quality Standard (TCVN6772-2000) Category IV		5000	50	-	100	-

[#1] Sampling point; "Effluent": Effluent from septic tank, "Sediments": Sediment sludge of tank bottom

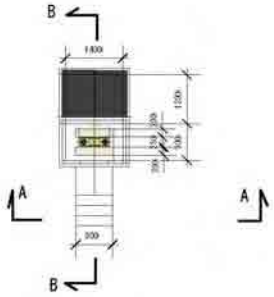
The results show that all values exceed the Vietnamese standard value for wastewater quality (TCVN6772-2000). And it is noted that significant difference between effluent and sediments of the same tank has not been observed, which implies less performance of reduction of polluting load by the existing septic tank.

1.9 Design Drawings of Model Toilets

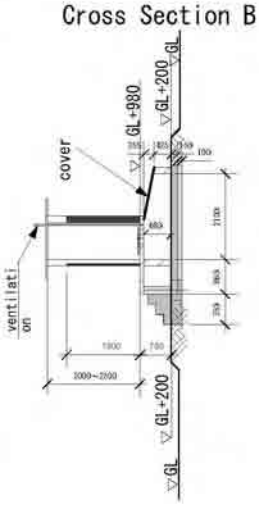




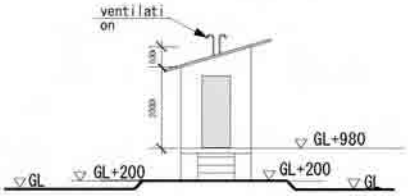
DVCL Plan for Residences

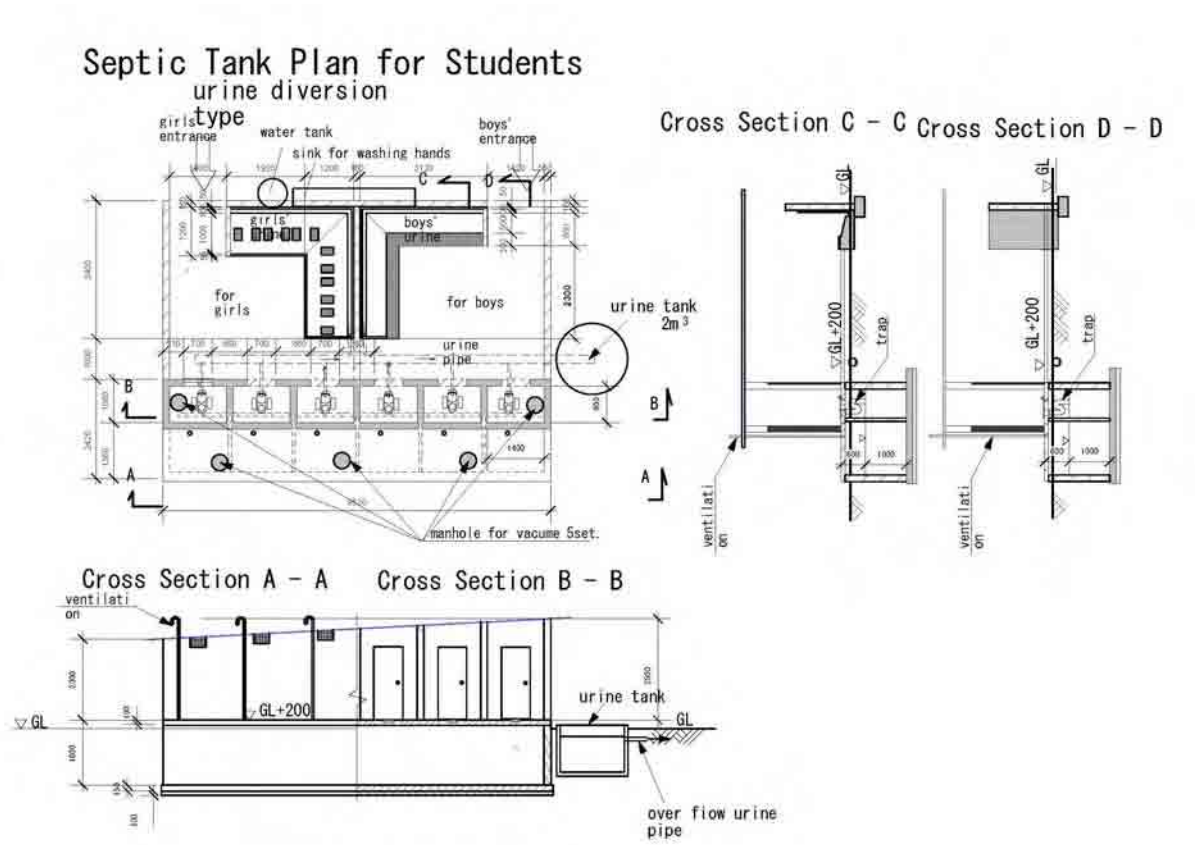


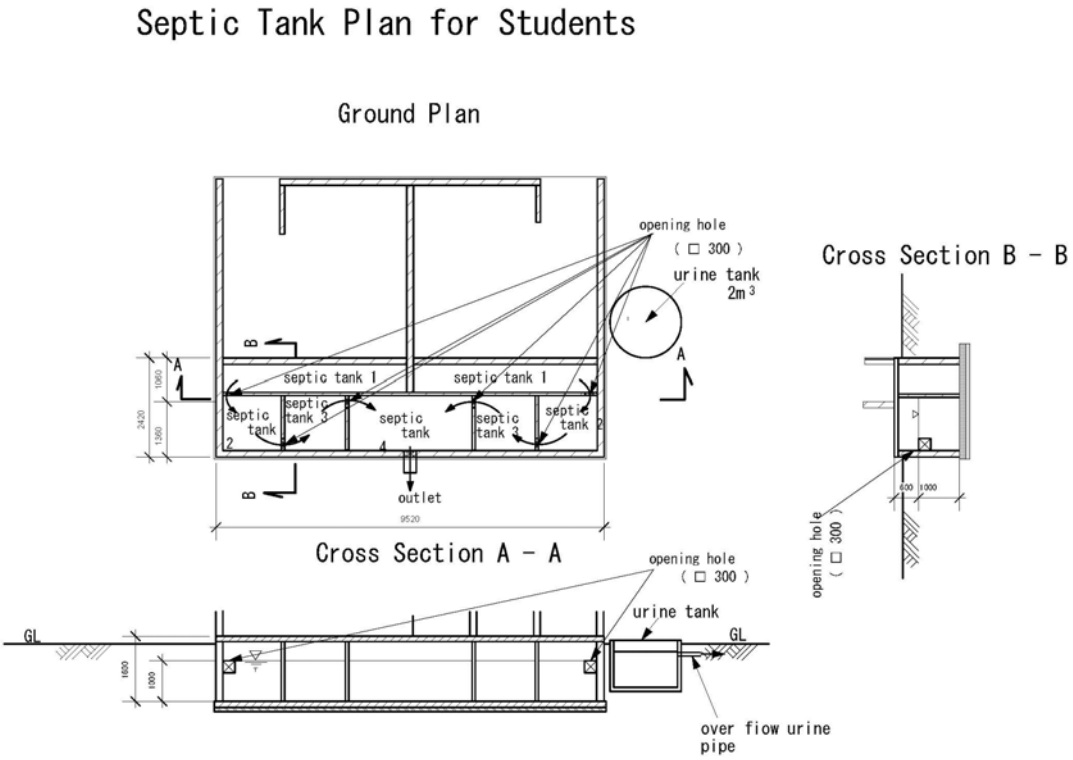
Cross Section B - B

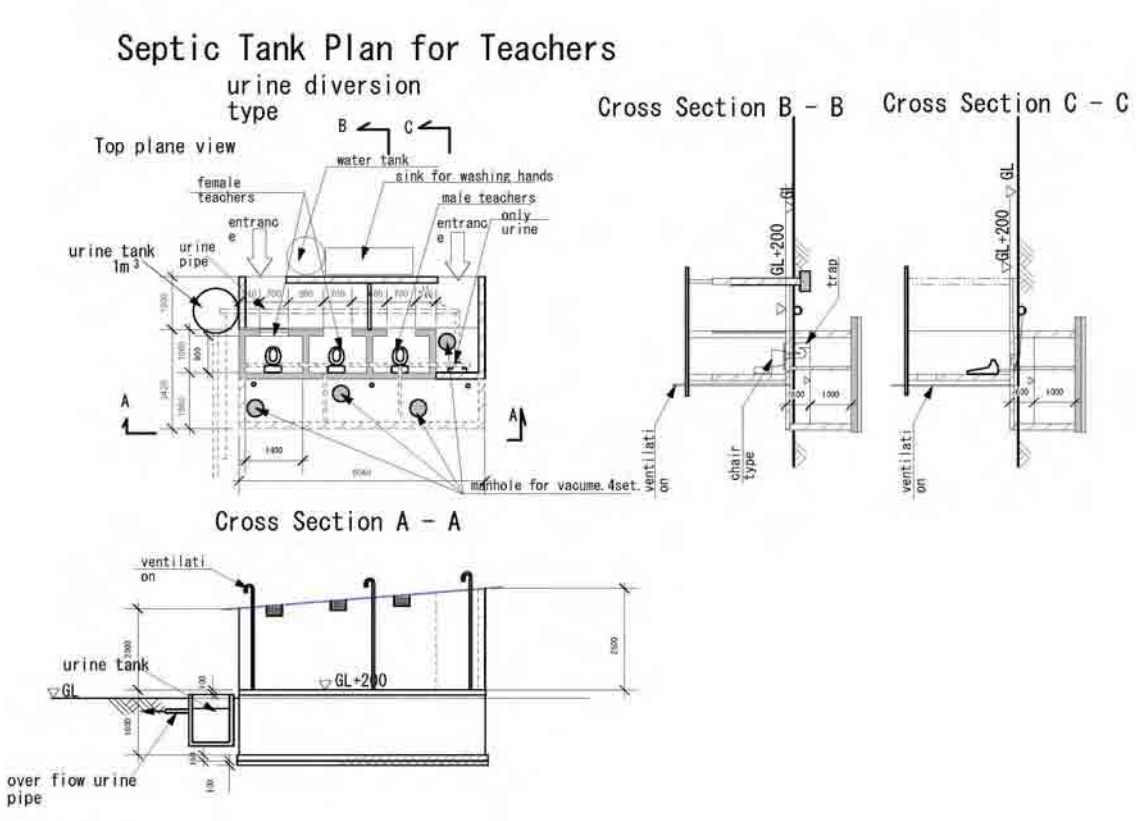


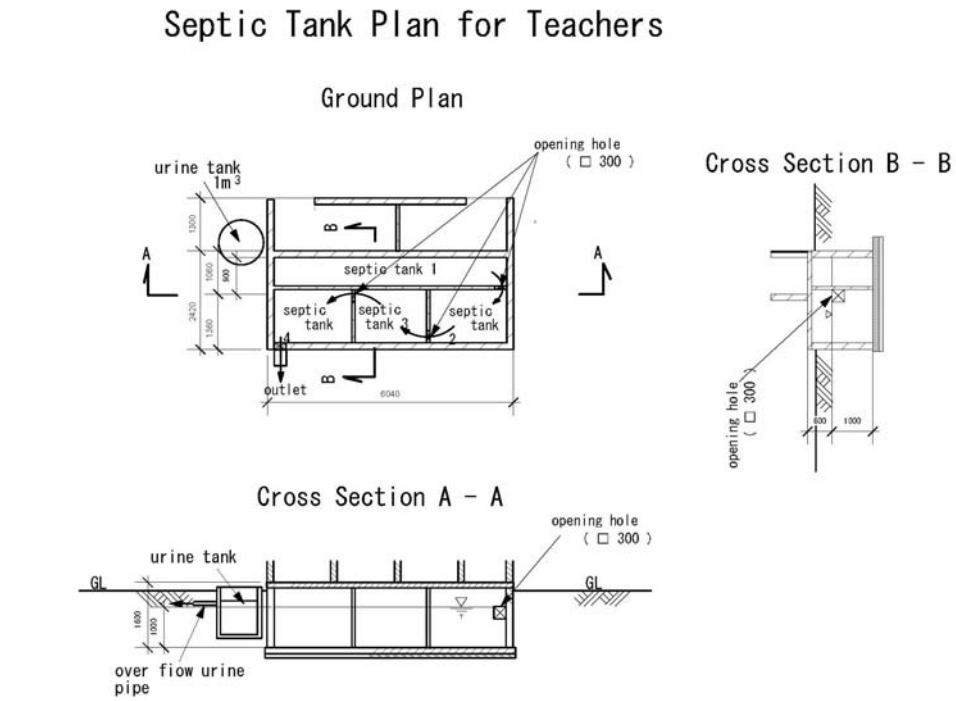
Cross Section A - A




Septic Tank Plan for Students
urine diversion type
girls entrance
water tank
sink for washing hands
boys' entrance
girls
boys' urine
for girls
for boys
urine pipe
urine tank 2m3
manhole for vacume Sset.
Cross Section C - C
Cross Section D - D
GL+200
trap
ventilation
Cross Section A - A
Cross Section B - B
GL
urine tank
over flow urine pipe

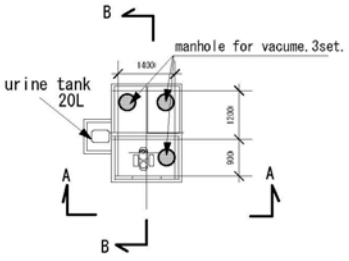

Septic Tank Plan for Students
Ground Plan
opening hole (□ 300)
urine tank 2m3
septic tank 1
septic tank 2
septic tank 3
septic tank 4
outlet
Cross Section B - B
Cross Section A - A
GL
over flow urine pipe


Septic Tank Plan for Teachers
urine diversion type
Top plane view
B
C
water tank
sink for washing hands
female teachers
male teachers
entrance
entrance
only urine
urine tank 1m3
urine pipe
A
A
manhole for vacume. 4set.
Cross Section B - B
GL
GL+200
trap
chair type
ventilation
Cross Section C - C
GL
GL+200
ventilation
Cross Section A - A
ventilation
urine tank
GL
GL+200
over flow urine pipe

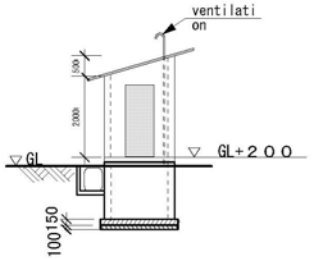

Septic Tank Plan for Teachers
Ground Plan
urine tank 1m3
opening hole (□ 300)
A
A
B
B
septic tank 1
septic tank 3
septic tank 2
septic tank
outlet
6040
Cross Section B - B
opening hole (□ 300)
600
1000
Cross Section A - A
opening hole (□ 300)
urine tank
GL
GL
over flow urine pipe

Septic Tank Plan for Residences

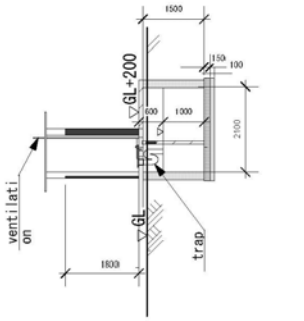
urine diversion type

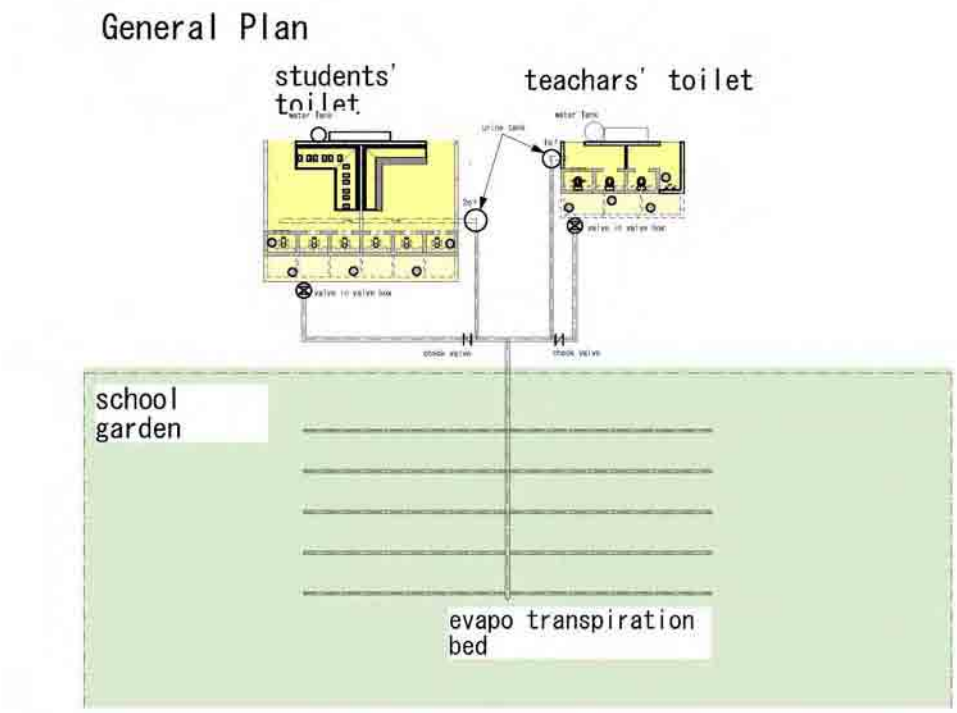


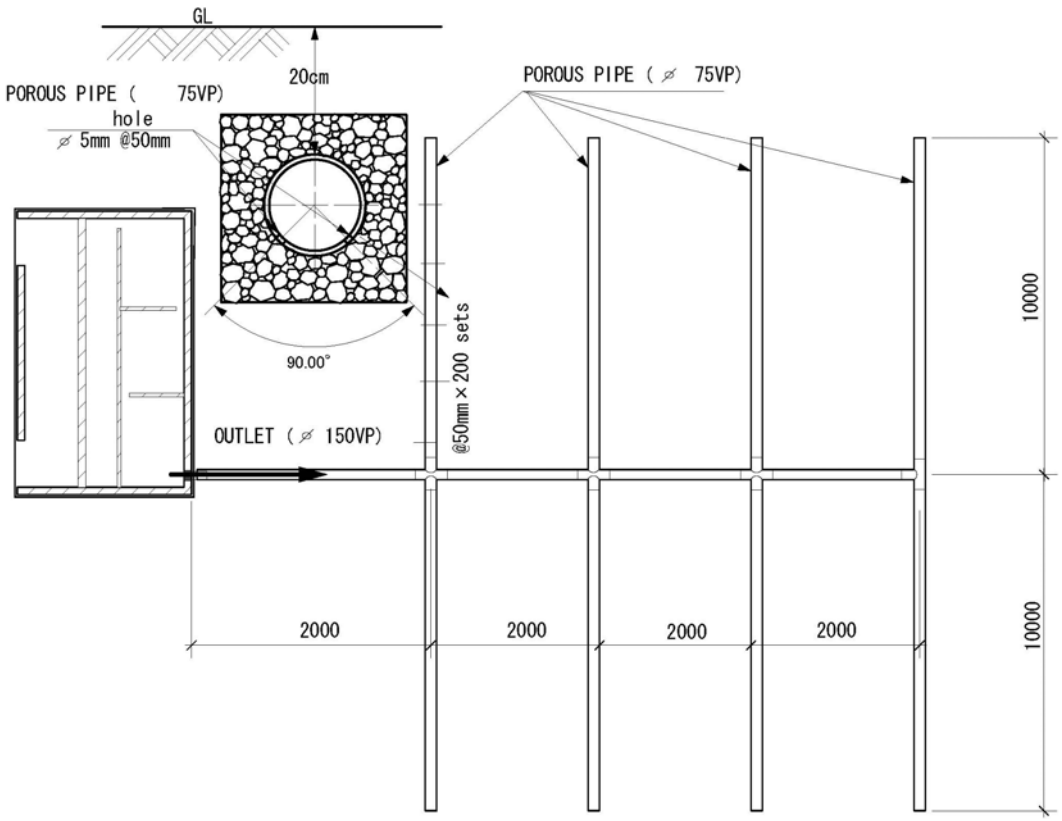
Cross Section A - A



Cross Section B - B




General Plan
students' toilet
teachars' toilet
school garden
evapo transpiration bed


GL
20cm
POROUS PIPE (75VP)
hole
⌀ 5mm @50mm
POROUS PIPE (⌀ 75VP)
90.00°
@50mm × 200 sets
OUTLET (⌀ 150VP)
10000
10000
2000
2000
2000
2000

1.10 Summary of Interview Results

Province	Commune	Name of School	[A] Number of Students	[B] Number of Teachers	[C1] Number of Toilets: Teacher	[C2] Number of Toilets: Boy	[C3] Number of Toilets: Girl	[D] Type of Toilet	[E] Conditions
Phu Yen	Xuan phuoc (P1)	Primary school -1	376	73				Septic tank	
		Primary school -2	469					Septic tank	
		Secondary school	1,493	90				Septic tank	
	An Dinh(P2)							Septic tank	
	An Tho(P3)	An Tho primary school	300	30	0	1	1	DVCL	Half broken
		An Tho secondary school	245	22	0	0	0	Not exist but plan to build toilet (To be septic tank)	N/A
	An My(P4)	An My primary school	674	40	0	0	0	Septic tank (under construction)	N/A
		Nguyen Thai Binh secondary school	1,000	52	0	1	1	Septic tank	Old but functioning
	Son Phuoc(P5)	Pi Nang Tac primary school	443	30	0	1	1	Septic tank	Girls' toilet not in use
		Vu A Dinh secondary school	257	23	0	1	1	Septic tank	Functioning
	Ea Cha Rang(P6)	Ea Cha Rang primary school (incl. 5 blanches)	345	33	0	0	0		Broken
		Dinh Nup day-boarded high school	295	30	1			Septic tank	Functioning
	Suoi Bac(P7)	Suoi Bac primary school (incl. 3 branches)	610	40	0	1	1	DVCL	Broken
		Suoi Bac secondary school	411	26	0	1	1	DVCL	Not functioning
	Son Thanh Dong (P8)	Son Thanh Dong primary school	636	35	0	0	0	N/A	N/A
		Dinh Tien Hoang secondary school	821	52	0	1	1	Septic tank	Functioning
Khanh Hoa	Cam An Bac(K1)	Cam An Bac primary school	684	36	2	2	2	Septic tank	Old but functioning. Teachers' toilet are under construction
		Nguyen Trai secondary school	640	29	0	1	1	Septic tank	Broken
	Cam Hiep Nam (K2)	Nguyen Cong Tru secondary school	617	34	0	1	1	Septic tank	Functioning
	Cam Hai Tay(K3)	Cam Hai Tay primary school	250	22	2	0	0	Septic tank	Functioning
Ninh Thuan	Nhon Hai (N1)	My Tuong primary school	684	22	0	2	2	Septic tank	Girls' toilets are broken
		Luong The Vinh secondary school	1508	62	1	1		Septic tank	Functioning. Teachers' was constructed in 2007
	Cong Hai(N2)	Cong Hai primary school	543	34	2	2	2	Septic tank	Broken (girls). 2 each more for teachers, boys and girls are demanded by the school
		Cong Hai secondary school						Septic tank	Broken
	Bac Son(N3)	Binh Nghia primary school	535	19	0	2	2	Septic tank	Functioning
	Phuoc Minh(N4)	Quan The primary school	138	6	2	1 for urine	1 for urine	Septic tank Students' toilets are only for urine (no feces)	Functioning
		Phan Chu Trinh secondary school	270	17	1	1	1	Septic tank	Functioning
	Phuoc Hai(N5)	Thanh Tin primary school	480		0	1 + urine	1 + urine	Septic tank	Functioning
		Phan Dinh Phung secondary school	1036		0	4	4		Functioning but very dirty
	Phuoc Dinh(N6)								
Binh Thuan	Muong Mang(B1)	Muong Mang primary school	518	27	2	2	2	Septic tank	Functioning, 4 for teachers and 15 for students are demanded by the school
	Gia Huynh(B2)	Gia Huynh primary school (including 2 branches)	278	21	1	1	1	Septic tank	One functioning and two (students) are broken
		Ba Ta primary school	467			5	5	Septic tank	New and functioning
	Nghi Duc(B3)								
	Tan Duc (B4)	Xa Tan Duc primary school (incl. 2 branches)	456	25	0	1	1	Septic thank	Broken
	Me Pu(B5)	MePu primary school	474		0	1	1	Septic tank	Functioning
	Sung Nhon(B6)	Sung Nhon 1primary school	679		0	1+urine		Septic tank	Not functioning
		Sung Nhon secondary school	860		1	0	0	Septic tank	Not functioning
	Da Kai(B7)								

(Note)
The Study Team interviewed key informant of the communes and schools, in order to overview current situation.
The figure might be inconsistent with the other study results, such as socio-economic survey, etc.

(Information source)
[A], [B], [C], [F], [G], [H] Information provided by representative of school
[D], [E] Observation by the Study Team
[I], [J], [K] Information provided by representative of CPC

Province	Commune	Name of School	[F] Access to Water	[G] Use of vacuum car	[H] Willingness to improve
Phu Yen	Xuan phuoc (P1)	Primary school -1	Short in dry season		
		Primary school -2	Deep well has enough water		
		Secondary school			
	An Dinh(P2)		High water in wet season		
	An Tho(P3)	An Tho primary school	Short in dry season	Easy to get vacuum	Yes
		An Tho secondary school	Enough		
	An My(P4)	An My primary school			Yes
		Nguyen Thai Binh secondary school			Yes
	Son Phuoc(P5)	Pi Nang Tac primary school			
		Vu A Dinh secondary school			
	Ea Cha Rang(P6)	Ea Cha Rang primary school (incl. 5 blanches)	Short in dry season	No vacuum car used	
		Dinh Nup day-boarded high school			Yes
	Suoi Bac(P7)	Suoi Bac primary school (incl. 3 branches)	Short in dry season	No vacuum car used	
		Suoi Bac secondary school			Yes
	Son Thanh Dong (P8)	Son Thanh Dong primary school			Yes
		Dinh Tien Hoang secondary school			
Khanh Hoa	Cam An Bac(K1)	Cam An Bac primary school	Enough	To be desludged every 5 to 10 years	
		Nguyen Trai secondary school	Enough		
	Cam Hiep Nam (K2)	Nguyen Cong Tru secondary school	Short in dry season		Yes
	Cam Hai Tay(K3)	Cam Hai Tay primary school	Short in dry season	500,000VND/time	Yes
Ninh Thuan	Nhon Hai (N1)	My Tuong primary school	Desalting instrument Enough for hand-washing	No vacuum car used	Yes
		Luong The Vinh secondary school	No water in dry season	No vacuum car used	
	Cong Hai(N2)	Cong Hai primary school	Getting water from the agriculture pond		Yes
		Cong Hai secondary school			
	Bac Son(N3)	Binh Nghia primary school		5 to 6 vacuum cars in Ninh Thuan	Yes
	Phuoc Minh(N4)	Quan The primary school	Enough for hand-washing in dry season		Yes
		Phan Chu Trinh secondary school	No water in dry season		
	Phuoc Hai(N5)	Thanh Tin primary school	No water in dry season	Never vacuum car used since 1999 (8years)	Yes
		Phan Dinh Phung secondary school			
	Phuoc Dinh(N6)				
Binh Thuan	Muong Mang(B1)	Muong Mang primary school	Short in dry season		Yes
	Gia Huynh(B2)	Gia Huynh primary school (including 2 branches)	Short in dry season		not much concerned
		Ba Ta primary school			
	Nghi Duc(B3)		Short in dry season	near 25km	
	Tan Duc (B4)	Xa Tan Duc primary school (incl. 2 branches)	Short in dry season		Yes
	Me Pu(B5)	MePu primary school	Short in dry season		Yes
	Sung Nhon(B6)	Sung Nhon 1primary school	Short in dry season		Yes
		Sung Nhon secondary school			Yes
	Da Kai(B7)				

(Note)
The Study Team interviewed key informant of the communes and schools, in order to overview current situation.
The figure might be inconsistent with the other study results, such as socio-economic survey, etc.

(Information source)
[A], [B], [C], [F], [G], [H] Information provided by representative of school
[D], [E] Observation by the Study Team
[I], [J], [K] Information provided by representative of CPC

Province	Commune	Name of School	[I] Sanitary Toilet Possession in	[J] Literacy Rate	[K] Ethnic Composition	[L] Remarks
Phu Yen	Xuan phuoc (P1)	Primary school -1 Primary school -2 Secondary school	60% (Septic tank & pour flush)	100%	Kinh:95% Cham and Hroi:75 households	People think septic tank is better option
	An Dinh(P2)		70%	100%	Kinh:100%	People seem generally rich. People don' have custom of fertilizing organic compost
	An Tho(P3)	An Tho primary school An Tho secondary school	1 - 5%	100%	Kinh:100%	
	An My(P4)	An My primary school Nguyen Thai Binh secondary school	70%	100%	Kinh: 100%	Some households use organic compost as fertilizer
	Son Phuoc(P5)	Pi Nang Tac primary school Vu A Dinh secondary school	0%	100%	Cham Hai:62.5% Kinh:37.5%	
	Ea Cha Rang(P6)	Ea Cha Rang primary school (incl. 5 blanches) Dinh Nup day-boarded high school	5% (Septic tank)	60%	Kinh: 10%; Ede: 70%; Cham H'roi: 10%; Tay, Kho me, Gia Rai: 10%	Eco-San project by Netherland grant failed in the past
	Suoi Bac(P7)	Suoi Bac primary school (incl. 3 branches) Suoi Bac secondary school	40% (DVCL), 1% (Septic tank)	90-100%	Kinh: 70%; Cham H'roi: 20%; ay,Ede,Bana,Nung: 10%	Septic tank:along national road DVCL:in the field
	Son Thanh Dong (P8)	Son Thanh Dong primary school Dinh Tien Hoang secondary school	20% (Septic tank)	85-100%	Kinh:99.9%; Ede: 0.1%(only four household)	
Khanh Hoa	Cam An Bac(K1)	Cam An Bac primary school Nguyen Trai secondary school	30% (Septic tank)	>95%	Kinh: 100%	Commune leader tells that there is a few waterborne disease
	Cam Hiep Nam (K2)	Nguyen Cong Tru secondary school	50% (Septic tank)	>95%	Kinh: 100%	There is no custom of using organic compost. People use chemical fertilizer
	Cam Hai Tay(K3)	Cam Hai Tay primary school	<50% (Septic Tank)	>95%	Kinh: 100%	People are well aware of environment DVCL is not popular
Ninh Thuan	Nhon Hai (N1)	My Tuong primary school Luong The Vinh secondary school	40% (Septic Tank)	100%	Kinh: 100%, some families are Hoa people	People don't seem to be concerned about sanitation
	Cong Hai(N2)	Cong Hai primary school Cong Hai secondary school	65% (Septic tank)	97%	Kinh:33%; Raglai: 67%	
	Bac Son(N3)	Binh Nghia primary school	40%	>90%	Kinh: 77%; Cham and Raglay: 23%:	
	Phuoc Minh(N4)	Quan The primary school Phan Chu Trinh secondary school	30% (Septic tank)	>90%	Kinh: 95%; Cham, Raglay,Muong: 5%	
	Phuoc Hai(N5)	Thanh Tin primary school Phan Dinh Phung secondary school	30-40% (Septic Tank)	100%	Kinh: 65%; Cham: 35%	
	Phuoc Dinh(N6)		60%	100%	Kinh: 100%	
Binh Thuan	Muong Mang(B1)	Muong Mang primary school	70%(Septic tank), 10%(DVCL)	100%	Kinh: 99%; Cham and Giarai: 1%	There is no custom of using organic compost. People use chemical fertilizer
	Gia Huynh(B2)	Gia Huynh primary school (including 2 branches) Ba Ta primary school	10% (Septic tank)	90%	Kinh90%; Churo:10%	There is no custom of using organic compost. People use chemical fertilizer
	Nghi Duc(B3)		10% (Septic tank)	100%	Kinh100%, Cham: 1 household	Fuel in use: gas & electricity:40% firewood:60% Some people think open air not bad
	Tan Duc (B4)	Xa Tan Duc primary school (incl. 2 branches)	35% (Septic tank)	<35 years old: 95%; >36 years old: 80%	biggest: kinh: 95%;Nung, Hoa,Muong: 5% second:Kinh73%,RaiRo27%	People changed from DVCL to septic tank
	Me Pu(B5)	MePu primary school	10% (Pour flash)	90%	Kinh: 95%; K'ho: 5%	Fuel in use: gas: 50% and firewood: 50% DVCL pilot project by MOH failed due to lack of ash
	Sung Nhon(B6)	Sung Nhon 1primary school Sung Nhon secondary school	70% (Septic tank), 10% (DVCL) 80%	100%	Kinh: 98%; Muong, Khome: 2%	
	Da Kai(B7)		15% (Septic tank)	100%		

(Note)
The Study Team interviewed key informant of the communes and schools, in order to overview current situation.
The figure might be inconsistent with the other study results, such as socio-economic survey, etc.

(Information source)
[A], [B], [C], [F], [G], [H] Information provided by representative of school
[D], [E] Observation by the Study Team
[I], [J], [K] Information provided by representative of CPC

ANNEX 2 CASE STUDY ON SEPTIC TANK SLUDGE TREATMENT

2.1 Introduction

As increasing coverage of septic tank toilet in rural area, treatment and disposal of septic tank sludge is growing environmental issues.

This case study presents preliminary design for the septic tank sludge treatment plant, on assumption that approx. 620,000 rural people have access to septic tank toilet. It also includes cost estimation and evaluation from the environmental point of view.

2.2 Design Conditions

(1) Septic tank sludge volume and design capacity

On assumption that 80% of population of Khanh Hoa Province have access to hygienic latrine and 75% of latrines are septic tank toilet, calculation on septic tank sludge volume and design capacities are presented in the Table 2.2.1.

Table 2.2.1 Calculation on Sludge Volume and Scale of Facility

	Parameter	Value	Remarks
[A]	Total population	1,034,800 persons	Population of Khanh Hoa (2006)
[B]	Population using hygienic latrines	827,840 persons	80%#1) of [A]
[C]	Population using septic tank toilet	620,880 persons	75%#2) of [B]
[D]	Unit wastewater volume	0.01 m^3/cap/day	Flushing water consumption: 10 L/c/day
[E]	Inflow to septic tank	6,209 m^3/day	= [C] x [D]
[F]	Septic tank sludge volume sucked out	1,825 m^3/day	= [C] x 0.2 L/cap/day #3) + 5m^3 #4) x [C] / 5 persons x (1/365) #5)
[G]	Septic tank sludge volume collected	1,825 m^3/day	= [F]
[H]	Design Treatment Capacity	2,190 m^3/day	= [G] x 1.2 #6)

(Note)
Followings are assumed for calculation purpose:
#1) Rate of population using hygienic latrines: 80% of total population
#2) Rate of population using septic tank toilet: 75% out of hygienic latrines
#3) Volume of feces per person: 0.2L/cap/day
#4) Volume of septic tank of a average family size of 5 persons: 5m^3
#5) Frequency of sludge sucking out: once a year
#6) Safety ratio: 20%

(2) Wastewater Quality

Unit wastewater load is assumed as Table 2.2.2, with reference to “Standard and Guideline to Design Septic Tank for Night Soil Treatment, 1984, Japan” Estimated volume of sludge sucked out is also presented in the Table 2.2.2. It is assumed that CODcr = SS, and that septic tank sludge doesn’t include toilet paper.

Table 2.2.2 Unit Wastewater Load

Parameter	Wastewater load #)	Estimated load to Suck out
BOD	13 g/cap/day	10 g/cap/day
SS	10 g/cap/day	10 g/cap/day
Total Nitrogen	9 g/cap/day	3 g/cap/day

(Note) "Standard and Guideline to Design Septic Tank for Night Soil Treatment, 1984, Japan"

Design water quality of septic tank sludge is estimated as follows:

BOD = 10 g/cap/day x 620,880 persons / 1,825m^3/day = 3,402 mg/L

SS = 10 g/cap/day x 620,880 persons / 1,825m^3/day = 3,402 mg/L

Total-N = 3 g/cap/day x 620,880 persons / 1,825m^3/day = 1,021 mg/L

(3) Treated Water Quality

Design treated water quality is set as follows, based on "Notification No.6 of the Design Standard for Night Soil Treatment, Japan."

BOD = 20 mg/L

SS = 50 mg/L

(4) Summary of Design Criteria

Design criteria is summarized in the Table 2.2.3.

Table 2.2.3 Design Criteria

Treatment capacity	2,190 m^3/day
Treated water volume	1,825 m^3/day
Inlet water	BOD: 3,402 mg/L SS: 3,402 mg/L T-N: 1,021 mg/L CODcr: 3,402 mg/L
Treated water quality	BOD: 20 mg/L SS: 50mg/L

(5) Others

Air temperature is estimated to be 25 degrees C or more throughout the year.

2.3 Treatment Flowchart and Mass Balance

Treatment process is proposed to be combination of anaerobic reactor and trickling filter methods. Flowchart and mass balance is presented in the Figure 2.3.1. Flowchart for composting facility is presented in the Figure 2.3.2. And the treatment process flowchart is shown in the Figure 2.3.3.

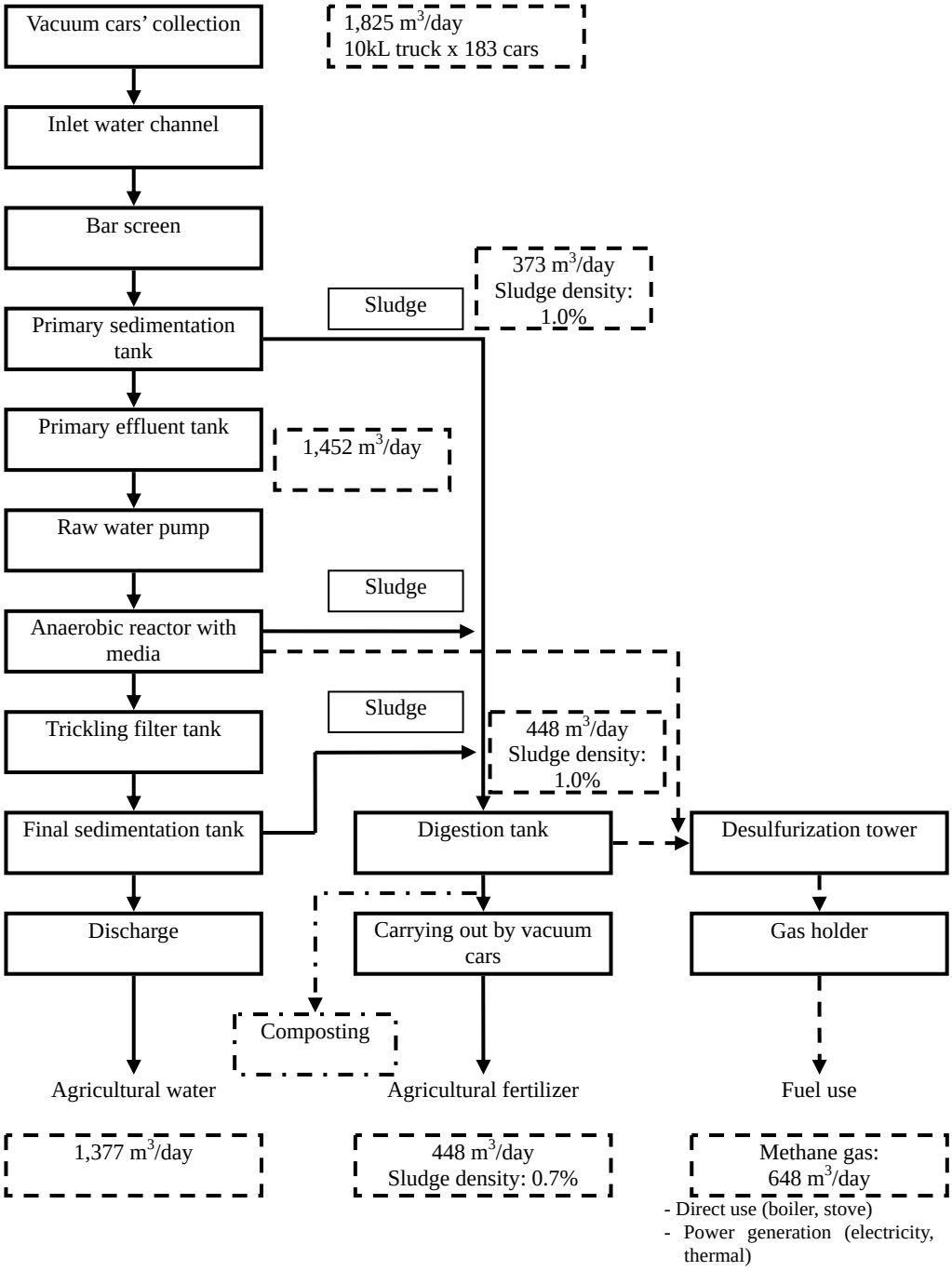


Figure 2.3.1 Flowchart and Mass Balance for Septic Tank Sludge Treatment

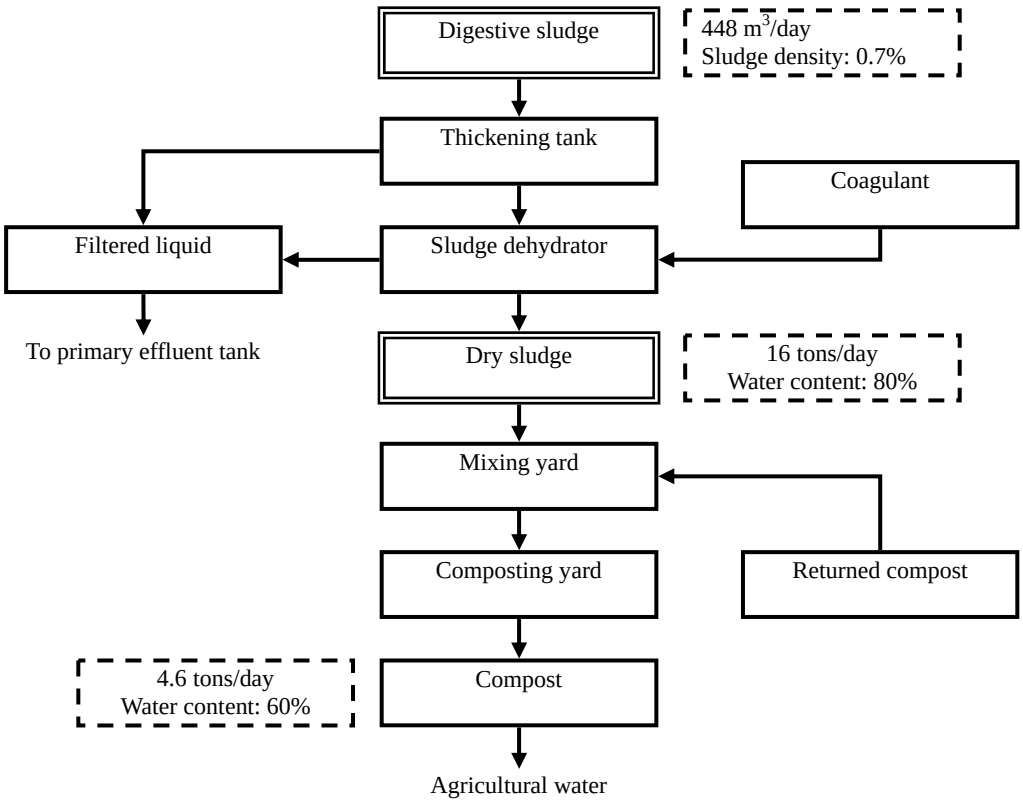


Figure 2.3.2 Flowchart and Mass Balance for Composting Facility

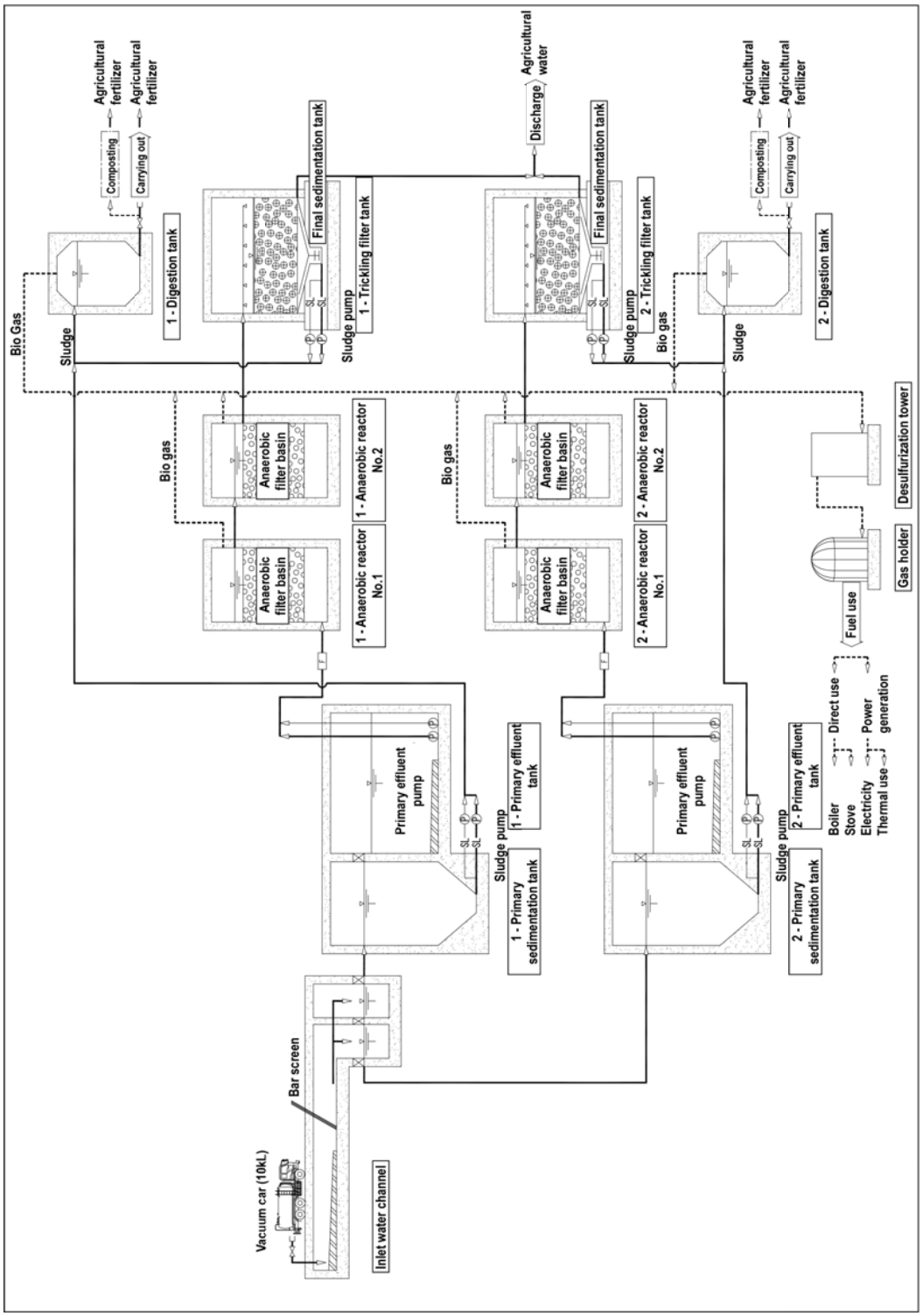


Figure 2.3.3 Process Flowchart of Septic Tank Sludge Treatment

2.4 Design Calculation

(1) Vacuum Cars' Collection

1) Number of vacuum cars: M

Capacity of vacuum car is assumed to be 10kL

M = 1,825 m^3/day / 10 kL/car = 183 cars/day

2) Collection time: T_1

T_1 = 8 hours/day

3) Time of entering, discharging and exit: T_2

T_2 = 20 min/car

(2) Inlet Water Channel

1) Number of inlet to be installed: E_1

E_1 = 183 cars/day / 8 hours/day x (20min / 60min/hour) = 7.6 … 8 nos.

2) Number of inlet water channels: E_2

E_2 = 2 channels

3) Number of inlet per channel: E_3

E_3 = 8 nos. / 2 channels = 4 nos./channel

4) Dimensions of channel

Width: 0.5 m

Height: 2.5 m

Effective depth: 0.5 m

Length: 30 m x 2 channels

(3) Bar Screen

Number of screen: C_1

C_1 = [One per channel] x [Number of channels: 2] = 2 nos.

(4) Primary Sedimentation Tank

1) Surface load: S_L

S_L = 8m/day

2) Tank Area: S

S = 2,190 m^3/day / 8 m/day = 274 m^2

3) Number / Dimensions

Number of trains: 2 trains ($153m^2$ x 2)

Effective depth: 1.5 m

Dimensions: Dia. 14m x 2 m Height

(5) Primary Effluent Tank

1) Volume: V_s

Water volume transmitted to primary effluent tank:

[2,190 m^3/day] – [sludge volume from the primary sedimentation tank: 373 m^3/day]

= 1,817 m^3/day

V_s = 1,817 m^3 – (1,817 m^3/day / 24 hours/day x 8hours) = 1,211 m^3

2) Number / Dimensions

Number of trains: 2 trains (676 m^3 x 2)

Effective depth: 4 m

Dimensions: 13m x 13 m x 5 m Height

(6) Primary Effluent Pump

1) Number of pumps: P_1

One pump per one train of primary effluent tank is assumed.

P_1 = 2 trains x 1 pump/train

= 2 pumps (4 pumps are to be installed on condition that one standby pump is installed per train)

2) Pump capacity: P_2

P_2 = 1,817 m^3/day / 24 hours/day x 60 min/hour / 2 pumps = 0.7 m^3/min/pump

(7) Anaerobic Reactor with Media No.1

1) BOD Removal

1,361 mg/L → 390 mg/L

2) BOD volume load: L_{U1}

L_{U1} = 3kg-BOD/m^3/day

3) Required UASB Volume: V_{U1}

BOD removal rate in the primary sedimentation tank is to be 60%.

V_{U1} = 1,817 m^3/day x 1,361 mg/L / 3kg-BOD/m^3/day = 824 m^3

4) Retention Time: T_{U1}

T_{U1} = 824 m^3 / 1,817 m^3/day = 10.9 hours

5) Number / Dimensions
Number of trains: 2 trains (416 m^3 x 2)
Effective depth: 6.5 m
Dimensions: 8m x 8 m x 7.5 m Height

(8) Anaerobic Reactor with Media No.2

1) BOD Removal
390 mg/L → 120 mg/L

2) BOD volume load: L_{U2}
L_{U2} = 1.5kg-BOD/m^3/day

3) Required UASB Volume: V_{U2}
V_{U1} = 1,817 m^3/day x 390 mg/L / 1.5 kg-BOD/m^3/day = 473 m^3

4) Retention Time: T_{U2}
T_{U2} = 473 m^3 / 1,817 m^3/day = 6.2 hours

5) Number / Dimensions
Number of trains: 2 trains (294 m^3 x 2)
Effective depth: 6.0 m
Dimensions: 7 m x 7 m x 7.0 m Height

(9) Methane Gas Generation Volume

1) Digestion gas generation volume: D_G
Inlet CODcr load = 1,825 m^3/day x 3,402 mg/L = 6,209 kg/day
Decomposition rate is to be 30%. And Digestion gas generation is to be 0.58 m^3/kg-decomposed CODcr.
D_G = 6,209 kg/day x 0.58 m^3/kg-decomposed CODcr = 1,080 m^3/day

2) Methane gas generation volume: M_G
Methane concentration in the digestion gas is to be 60%.
M_G = 1,080 m^3/day x 0.6 = 648 m^3/day

3) Methane gas heating value: C_{MG}
Lower heating value (LHV) of methane gas is to be 35.8 MJ/m^3
C_{MG} = 648 m^3/day x 35.8 MJ/m^3 = 23,198 MJ/day = 5,523 Mcal/day

(10) Trickling Filter Tank

1) Volume load for BOD removal: L_{U3}

L_{U3} = 0.7kg-BOD/ m^3-sponge /day

2) Required volume of sponge: V_{U3}

V_{U3} = 1,817 m^3/day x (120 – 20) mg/L / 0.7 kg-BOD/m^3-sponge /day = 260 m^3

3) Required volume of trickling filter tank: V_{U4}

V_{U4} = 260 m^3 / 0.45 (Filling rate of sponge: 45%) = 578 m^3

4) Retention time: T_{U4}

T_{U4} = 578 m^3 / 1,817 m^3/day = 7.6 hours

5) Number / Dimensions

Number of trains: 2 trains (303 m^3 x 2)

Effective depth: 3.2 m

Dimensions: Dia. 11m x 5.0 m Height

(11) Final Sedimentation Tank

1) Surface load: S_L

S_L = 7 m/day

2) Tank Area: S

S = 1,817 m^3/day / 7 m/day = 259 m^2

3) Number / Dimensions

Number of trains: 2 trains (153m^2 x 2)

Effective depth: 1.5 m

Dimensions: Dia. 14m x 2 m Height

(12) Digestion Tank

1) Sludge volume generated from the primary sedimentation tank: S_{U1}

Sludge density: 1%

S_{U1} = (10 g/cap/day x 620,880 persons x 0.6) / 0.01 = 372.5 … 373 m^3/day

2) Sludge volume generated from wastewater treatment system: S_{U2}

Sludge volume: 25% of SS of the septic tank sludge

S_{U2} = 1,817 m^3/day x 3,402 mg/L x 0.4 x 0.3 / 0.01 = 74.2 … 75 m^3/day

3) Total sludge volume: S_{U3}

S_{U3} = 373 m^3/day + 75 m^3/day = 448 m^3/day

4) Capacity of digestion tank

Retention time is to be 15 days.

V_{SU} = 448 m^3/day x 15 days = 6,720 m^3

5) Number / Dimensions

Number of trains: 2 trains (3,462 m^3 x 2)

Effective depth: 10 m

Dimensions: Dia. 21m x 11.0 m Height

(13) Desulfurization Tower

1) Diameter: D_{d1}

Gas volume: 54 m^3/hr (1,080 m^3/day x 1.2), Gas velocity: 1m/min

D_{d1} = (4 x 54 m^3/hr / (3.14 x 1 m/min x 60 min/hr))$^{0.5}$ = 1.07 … 1.1 m

2) Effective capacity: V_{d1}

Retention time is to be 2 min.

V_{d1} = 54 m^3/hr / 60 min/hr x 2min = 1.8 m^3

3) Effective height : H_{d1}

H_{d1} = 1.8 m^3 / 3.14 x (1.1/2)^2 m^2 = 1.9 m

(14) Gas Holder

1) Effective capacity: V_{G1}

Retention volume is to be a half day volume of generated digestion gas.

V_{G1} = 1,080 m^3/day x 1.2 x 1/2 = 648 m^3 … 650 m^3

2) Number / Dimensions

Number of trains: 2 trains (325 m^3 x 2)

Dimensions: Dia. 7m x 9.0 m Height

(15) Buildings

1) Administration office: 1

2) Electric room: 1

3) Water quality laboratory: 1

4) Electric power generation room: 1

(16) Composting Yard

Land area: Sc

Sc = 2,250 m^2 (15 m x 150 m) for 45 days retention, including working space

(17) Tentative Layout Plan

The tentative layout plan is presented in Figure 4.

Land area required for the plant: 150m x 125m =18,750 m^2

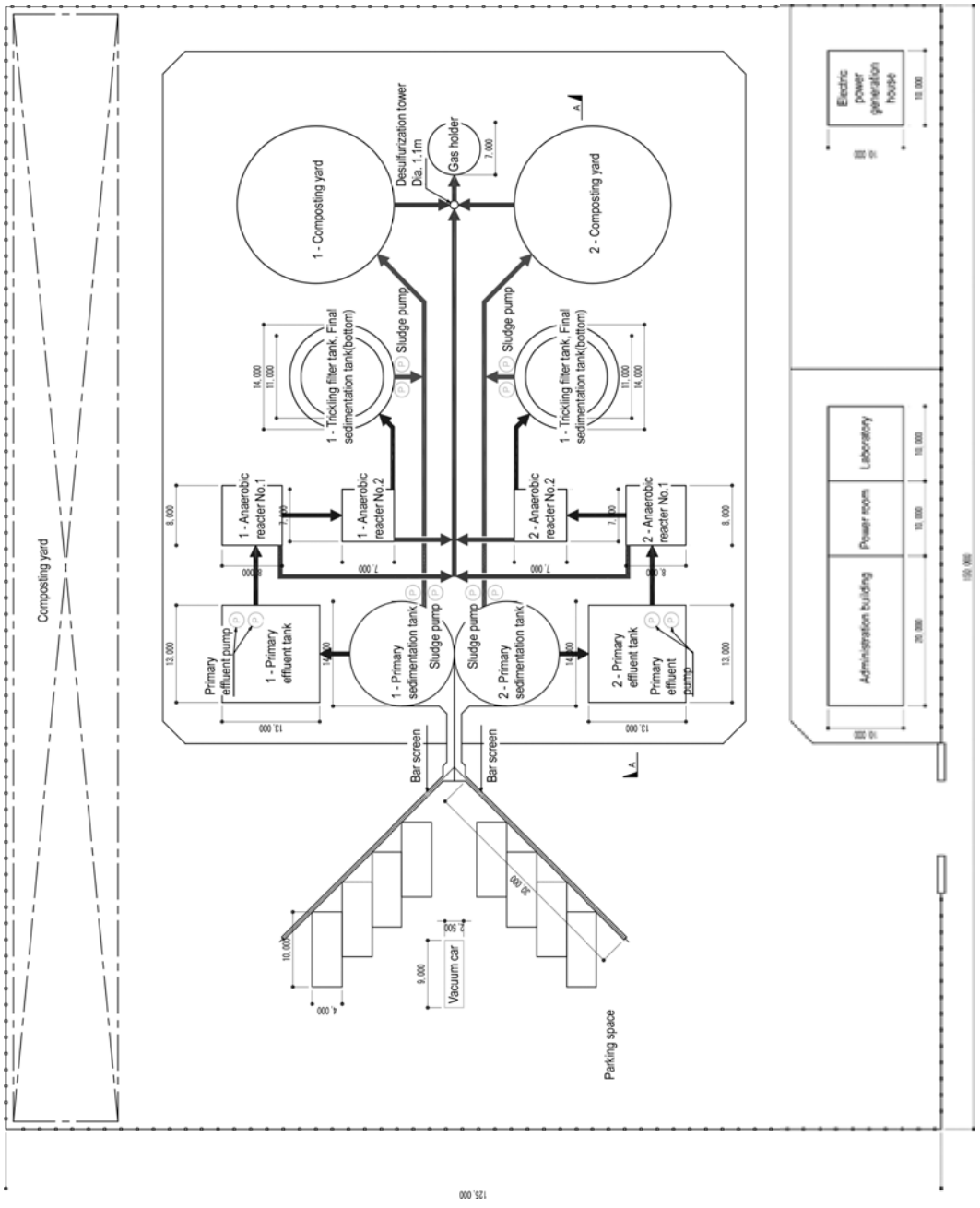


Figure 2.4.1 Tentative Layout Plan

2.5 Tentative Cost Estimation

(1) Construction Cost

Total construction cost for the septic tank sludge treatment plant is tentatively estimated to be USD 27.1 million as shown in the Table 2.5.1.

Table 2.5.1 Cost Estimation for the Septic Tank Sludge Treatment Plant

Item	Qty	Unit	Amount (1000 USD)
Civil Work			
- Inlet water channel	80	m^3	110
- Transfer water channel	90	m^3	120
- Primary sedimentation tank	620	m^3	850
- Primary effluent tank	1,690	m^3	2,300
- Anaerobic reactor with media No.1	960	m^3	1,310
- Anaerobic reactor with media No.2	690	m^3	940
- Trickling filter tank	950	m^3	1,300
- Final sedimentation tank	620	m^3	850
- Digestion tank	6,720	m^3	9,160
- Asphalt pavement	7,000	m^2	160
- Fence	500	m	20
- Entrance gate	1	set	20
- Planting work	1,600	trees	10
Sub total			17,150
Architecture Work			
- Administration building	200	m^2	550
- Power control room	100	m^2	270
- Water quality laboratory	100	m^2	270
- Electric power generation house	100	m^2	270
- Composting yard	2,250	m^2	1,020
Sub total			2,380
Mechanical Work			
- Bar screen	2	units	70
- Raw water pump	4	units	70
- Anaerobic reactor with media and trickling filter tank	260	m^3	590
- Sludge scraper	4	units	1,810
- Sludge pump	8	units	240
- Desulfurization tower	1	set	360
- Gas holder	1	set	1,920
- Digestion tank ancillary work	1	set	910
Sub total			5,970
Electric Work			
- Electric power generator	1	unit	110
- Electric installation work	1	set	1,520
Sub total			1,630
Grand Total			**27,130**

(Note) Cost estimation based on standard cost of Japan Sewage Works Agency.

(2) O&M Cost

O&M cost for the plant is estimated as follows:

1) Electric power cost:

304,500 kWh/year x 1000 VND/kWh = 340,500,000 VND/year

2) Spare parts and consumables:

407,000,000 VND/year

Total O&M Cost = 747,500,000 VND/year

2.6 Environmental Effect

(1) Reduction of BOD Load

BOD load discharged to water body is remarkably reduced by treatment of septic tank sludge. Reduction volume is calculated as below, on assumption that BOD is not reduced in septic tanks:

Be = 1,825 m^3/day x (3,402 – 20) mg/L = 6,172 kg-BOD/day

(2) Reduction of Fuel Consumption

Fuel consumption can be reduced by utilizing 648 m^3/day of methane gas generated in the treatment plant for domestic and industrial use.

Reduction of fuel consumption, as heavy oil, is estimated as the following calculation. Where, heating value of methane gas is to be 35.8 MJ/m^3 ("Guideline for sewerage facility design, Japan"), and value of heavy oil is to be 39.1 MJ/L ("Standard heating value by energy source, 2002, Japan").

F_1 = 648 m^3-methane gas/day x 35.8 MJ/m^3 = 23,198 MJ/day

= 593 L-heavy oil/day

(3) Reduction of GHG (Global Greenhouse Gas) Emission

In case that septic tank sludge is disposed without treatment, human wastes are anaerobic decomposed to be discharged into air which contributes global warming. On the other hand, in case that septic tank sludge is treated by the plant, GHG emission is reduced by collecting and utilizing methane gas.

1) CO_2 emission without septic tank sludge treatment

Methane gas volume generated in septic tanks and disposal sites: Q_{MG1} is estimated to be the same volume with gas collected in the treatment plant.

Q_{MG1} = 648 m^3/day

As effects of methane gas to global warming is 21 times of CO_2, CO_2 emission converted from methane gas volume; $Q_{CO2(1)}$ is calculated as follows:

$Q_{CO2(1)}$ = 648 m^3/day x (16/22.4) x 21 = 9,720 kg-CO_2/day

2) CO_2 emission with septic tank sludge treatment

Since methane gas collected from human wastes is carbon neutral, which is a status of balancing carbon release and emission, fuel consumption can be reduced by using the generated methane gas. As the result, CO_2 emission is reduced.

On assumption that the generated methane gas is used as alternative fuel of heavy oil, and that CO_2 emission of heavy oil is to be 0.0693 kg-CO_2/MJ ("Guideline for calculation method on GHG emission, Ministry of Environment, Japan, 2003"), the CO_2 reduction: $Q_{CO2(2)}$ is calculated as follows:

$Q_{CO2(2)}$ = 23,198 m^3/day x 0.0693 kg-CO_2/MJ = 1,608 kg-CO_2/day

Total reduction of CO_2 emission by septic tank sludge treatment is calculated as follows:

$Q_{CO2} = Q_{CO2(1)} + Q_{CO2(2)}$

= 9,720 kg /day + 1,608 kg /day

= 11,328 kg-CO_2/day… (x 365 day/year = 4,135 tons/year)

(Reference: consideration of CO_2 from electricity consumption in the plant)

CO_2 emission by electric consumption by treatment plant is considered in the case of the above CO_2 reduction (Q_{CO2}).

The power consumption of the treatment plant is 834 kWh/day. And the CO_2 emission by thermal power plant is given as 0.378 kg-CO_2/kWh ("Guideline for calculation method on GHG emission, Ministry of Environment, Japan, 2003").

$Q_{CO2(3)}$ = 834 kWh/day x 0.378 kg-CO_2/kWh = 315 kg/day

Reduction of CO_2 emission: $Q'_{CO2(2)}$

$Q'_{CO2(2)} = Q_{CO2(2)} - Q'_{CO2(3)}$ = 1,608 kg/day – 315 kg/day = 1,293 kg-CO_2/day

Total reduction of CO_2 emission by septic tank sludge treatment is calculated as follows:

$Q'_{CO2} = Q_{CO2(1)} + Q'_{CO2(2)}$ = 9,720 kg/day + 1,293 kg/day

= 11,013 kg/day … 4,020 tons/year

2.7 Items to be Further Studied

Septic tank sludge treatment is preliminarily examined based on available data and assumptions. It is necessary to verify the results through the actual pilot plant operation. The following items should be further studied.

1) Wastewater volume
2) Water quality of the septic tank sludge

3) BOD volume load of UASB, required retention time

4) BOD volume load of trickling filter tank, required retention time

5) Sludge volume from the treatment plant

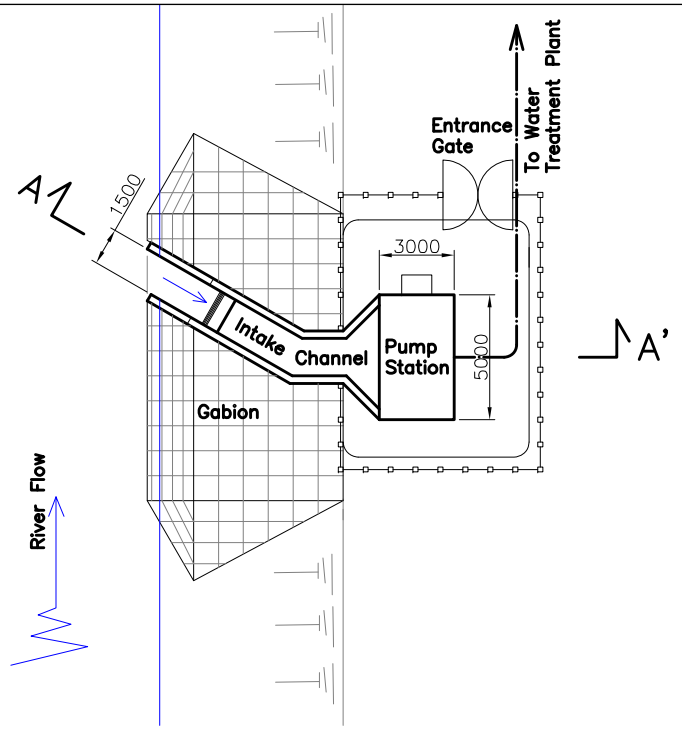
6) Methane gas generation volume

ANNEX 3 DRAWING OF WATER SUPPLY SYSTEM

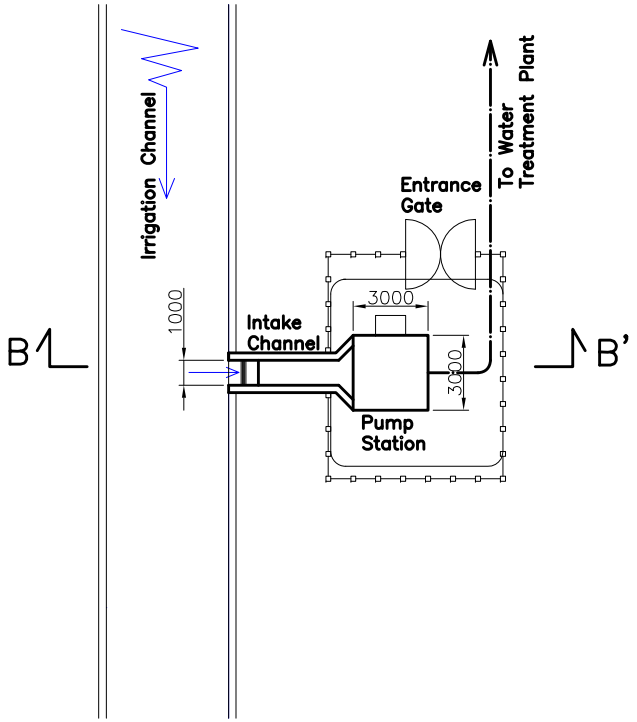
List of Drawings

DWG No.	Title of Drawing
1	Intake facility, System FPG-4, FKS-8
2	Intake facility, System FNG-10, FBS-10
3	Intake facility, System FBG-13
4	General arrangement of water treatment plant, System FPS-2, FPG-4
5	General arrangement of water treatment plant, System FNG-10
6	General arrangement of water treatment plant, System FBS-11
7	General arrangement of water treatment plant, System FKS-6
8	General arrangement of water treatment plant, System FKS-8
9	General arrangement of water treatment plant, System FBS-13
10	Typical flow sheet, System FPS-2, FPG-4, FBS-11
11	Typical flow sheet, System FNG-10, FBG-13
12	Typical flow sheet, System FKS-8
13	Sedimentation basin, System FPS-2
14	Sedimentation basin, System FPG-4
15	Sedimentation basin, System FNG-10
16	Sedimentation basin, System FBS-11
17	Sedimentation basin, System FBG-13
18	Rapid sand filter, System FPS-2
19	Rapid sand filter, System FPG-4
20	Rapid sand filter, System FNG-10
21	Rapid sand filter, System FBG-11
22	Rapid sand filter, System FBG-13
23	Slow sand filter, System FKS-6
24	Compact water treatment unit, Coagulation and sedimentation tank, System FKS-8
25	Compact water treatment unit, Filter and clear water tank, System FKS-8
26	Distribution reservoir (Type-1)
27	Distribution reservoir (Type-2)

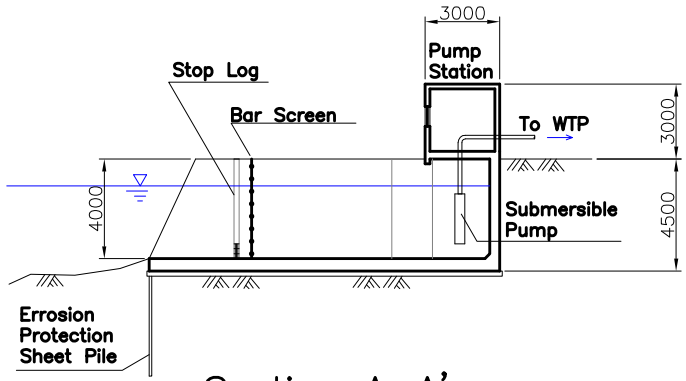
ANNEX 3-2



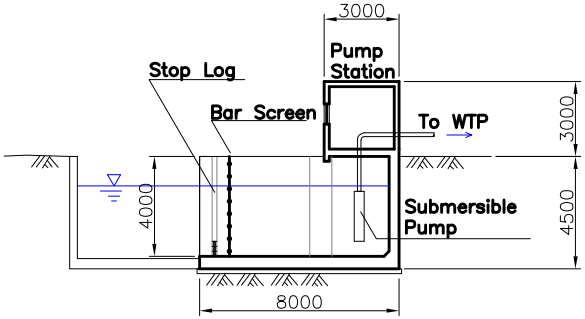
Layout Plan



Layout Plan



Section A–A'
SYSTEM FPG–4

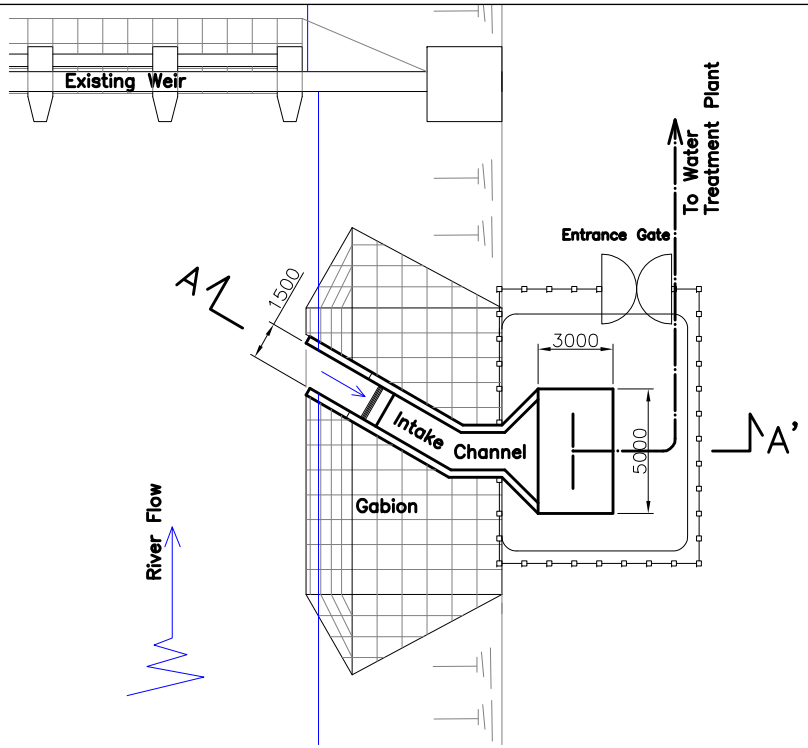


Section B–B'
SYSTEM FKS–8

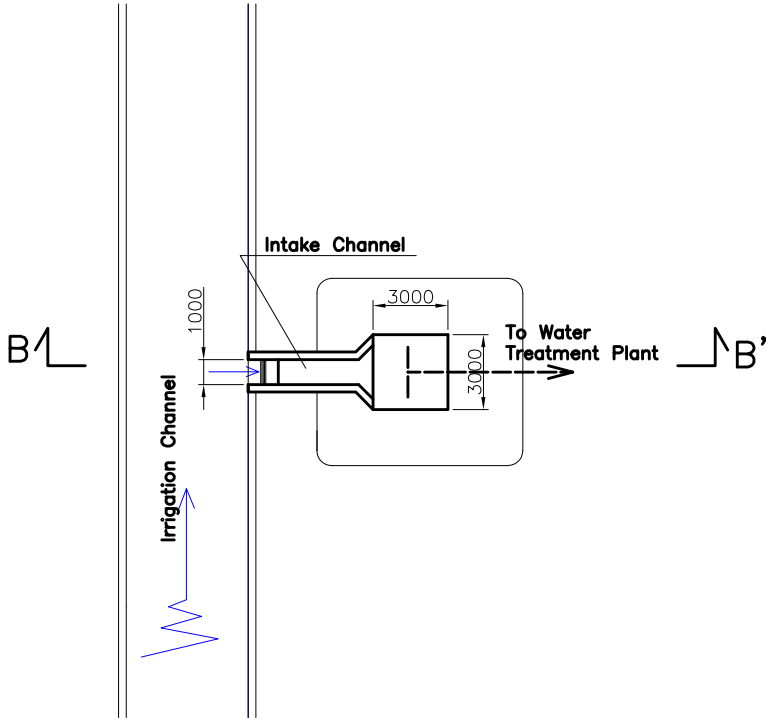
Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Intake facility System FPG-4, FKS-8	Scale : 1/300	DRW. No.1

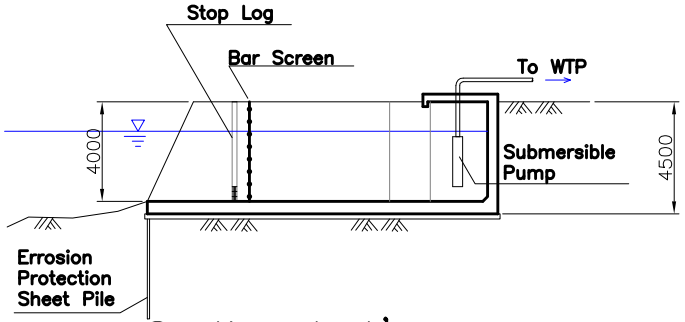
ANNEX 3-3



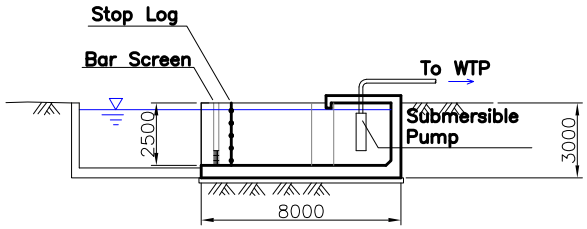
Layout Plan



Layout Plan



Section A–A'
SYSTEM FNG–10



Section B–B'
SYSTEM FBS–11

Preliminary

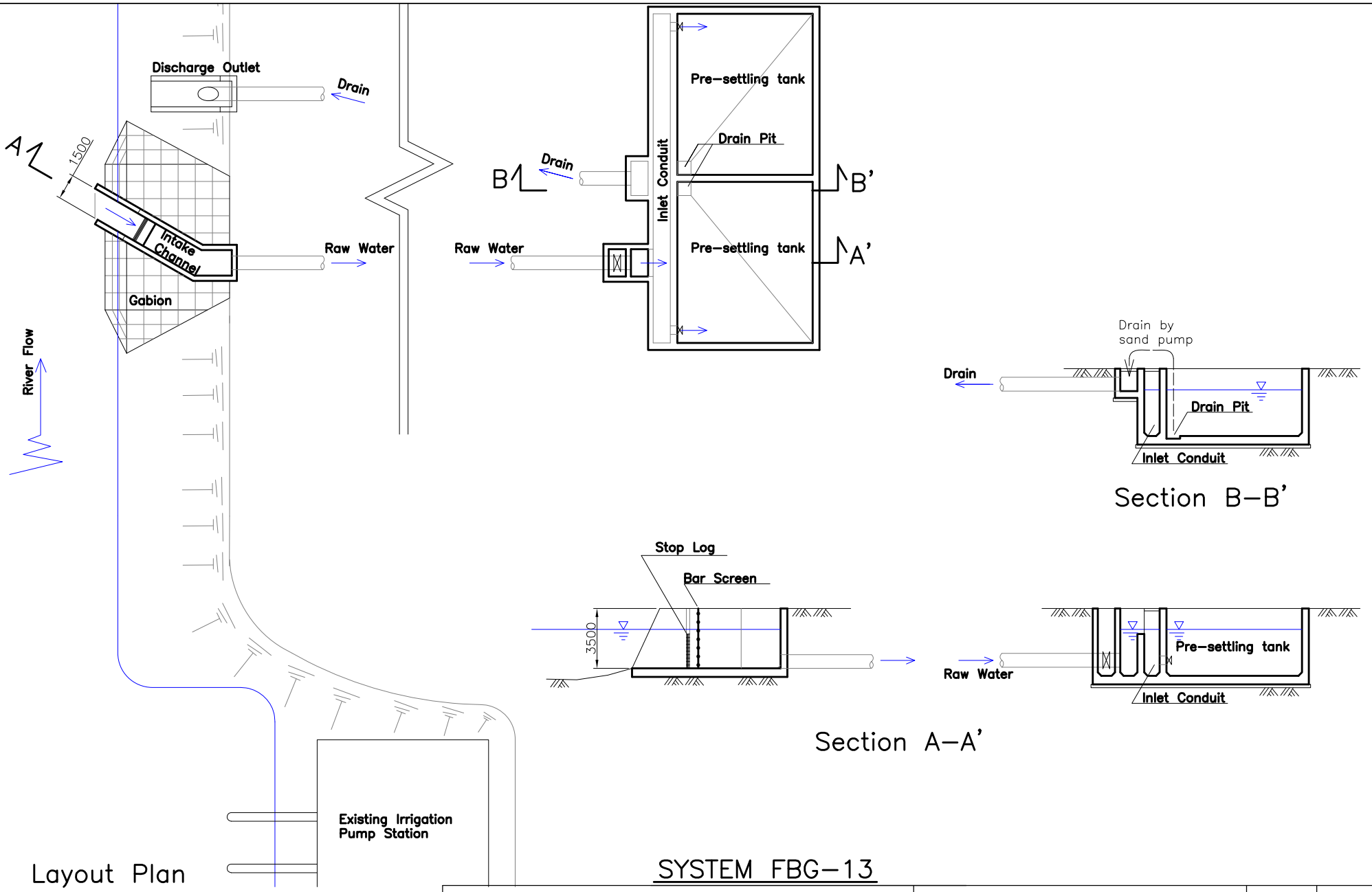
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM

Intake facility
System FNG-10, FBS-11

Scale :
1/300

DRW. No.2

ANNEX 3-4

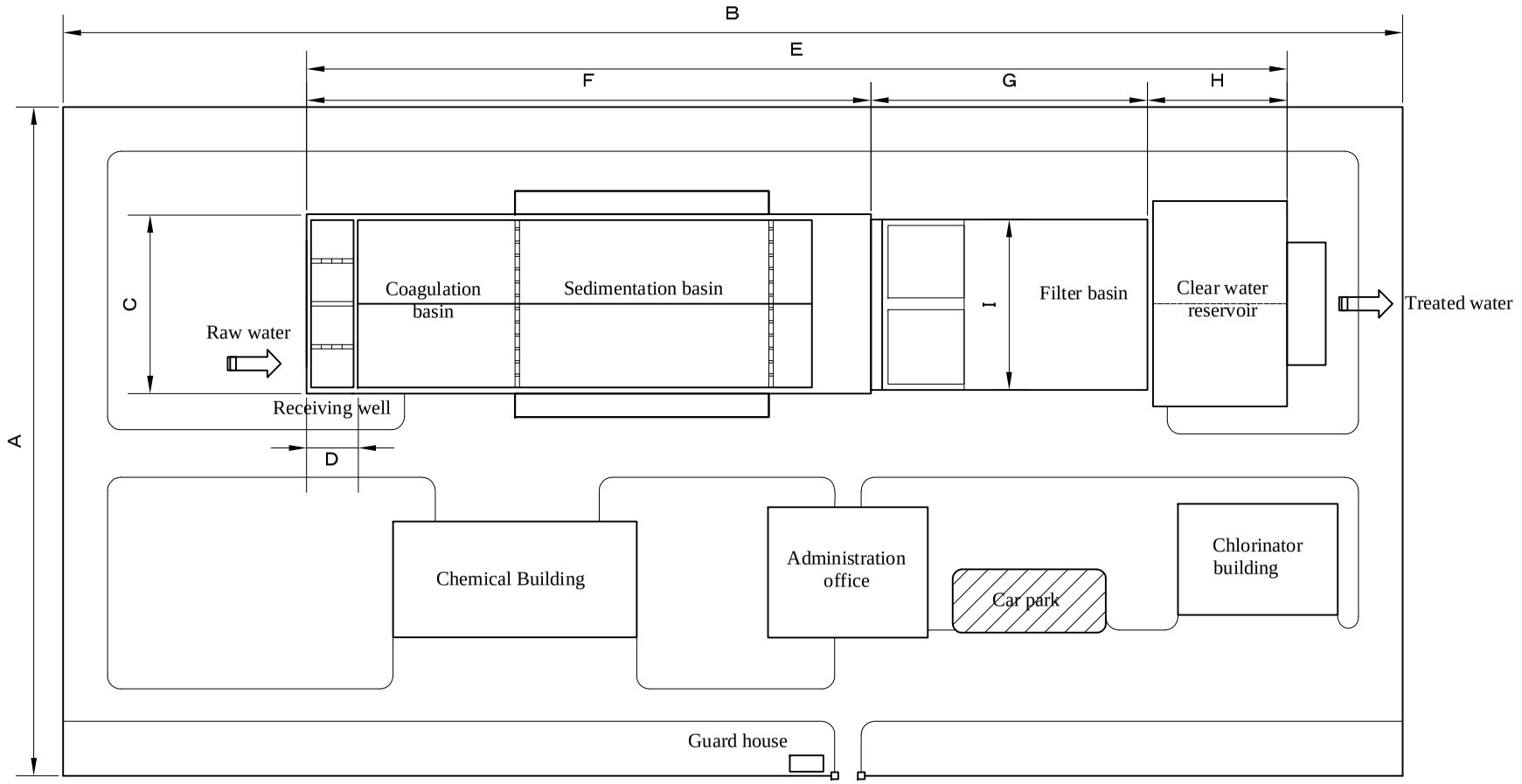


SYSTEM FBG-13

Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Intake facility System FBG-13	Scale : 1/300	DRW. No.3

ANNEX 3-5

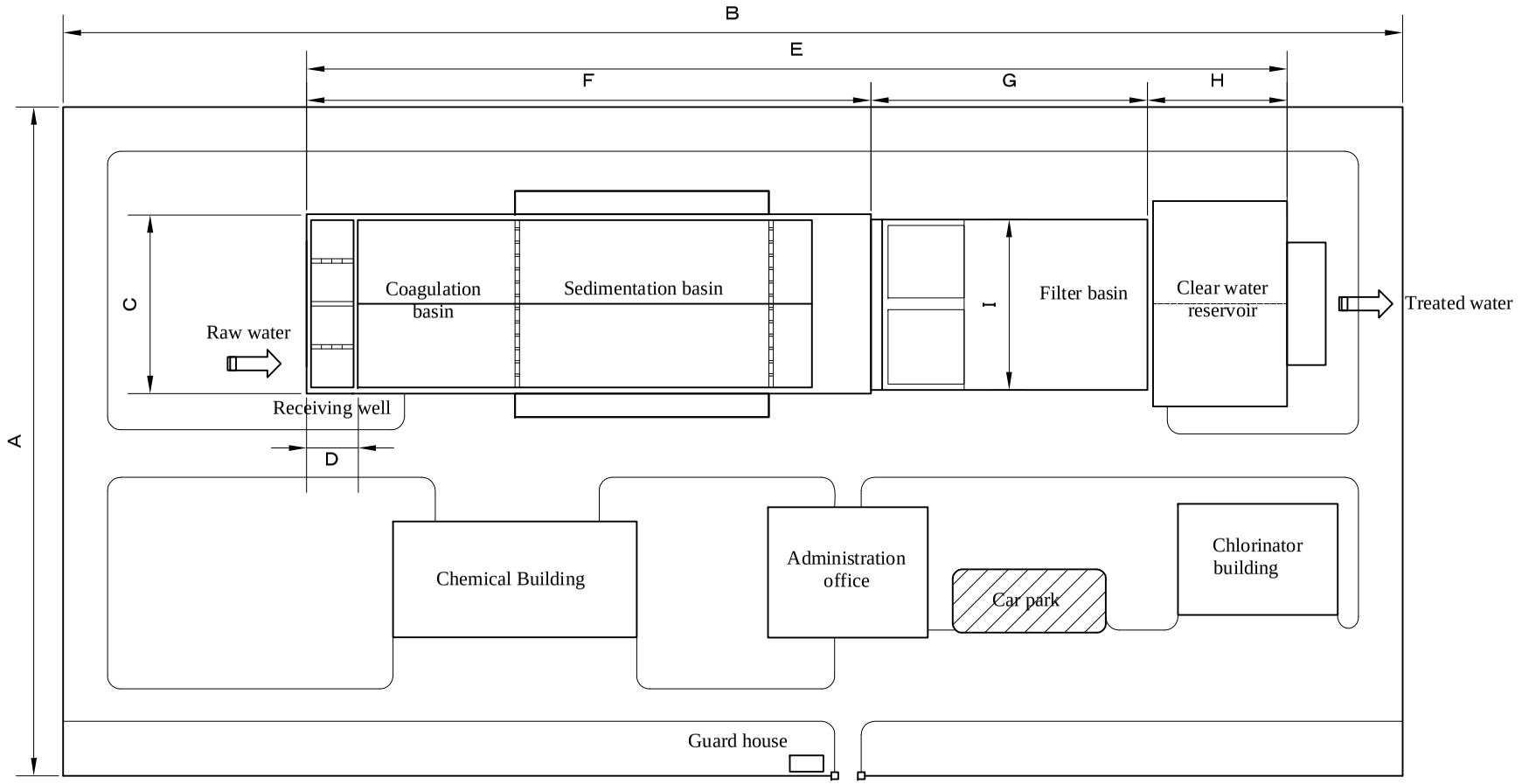


Dimension															
System	Raw water flow capacity (m3/d)	Total dimension		Required Area (m2)	Equipment dimension (m)							Building area (m2)			
		A	B		C	D	E	F	G	H	I	Chemical	Chlorinator	Administration	
FPS-2	700	25	40	1,000	6.3	1.3	28.5	16.5	8.0	4.0	5.9	40	25	30	
FPG-4	1,100	30	55	1,650	7.9	1.5	39.7	20.0	8.7	11.0	7.1	50	25	30	

Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	General arrangement of water treatment plant System FPS-2, FPG-4	Scale : Non	DRW. No.4

ANNEX 3-6



Dimension															
System	Raw water flow capacity (m3/d)	Total dimension		Required Area (m2)	Equipment dimension (m)							Building area (m2)			
		A	B		C	D	E	F	G	H	I	Chemical	Chlorinator	Administration	
FNG-10	2,900	65	65	4,225	11.1	2.3	53.5	26.4	10.6	16.5	15.8	60	30	30	

Preliminary

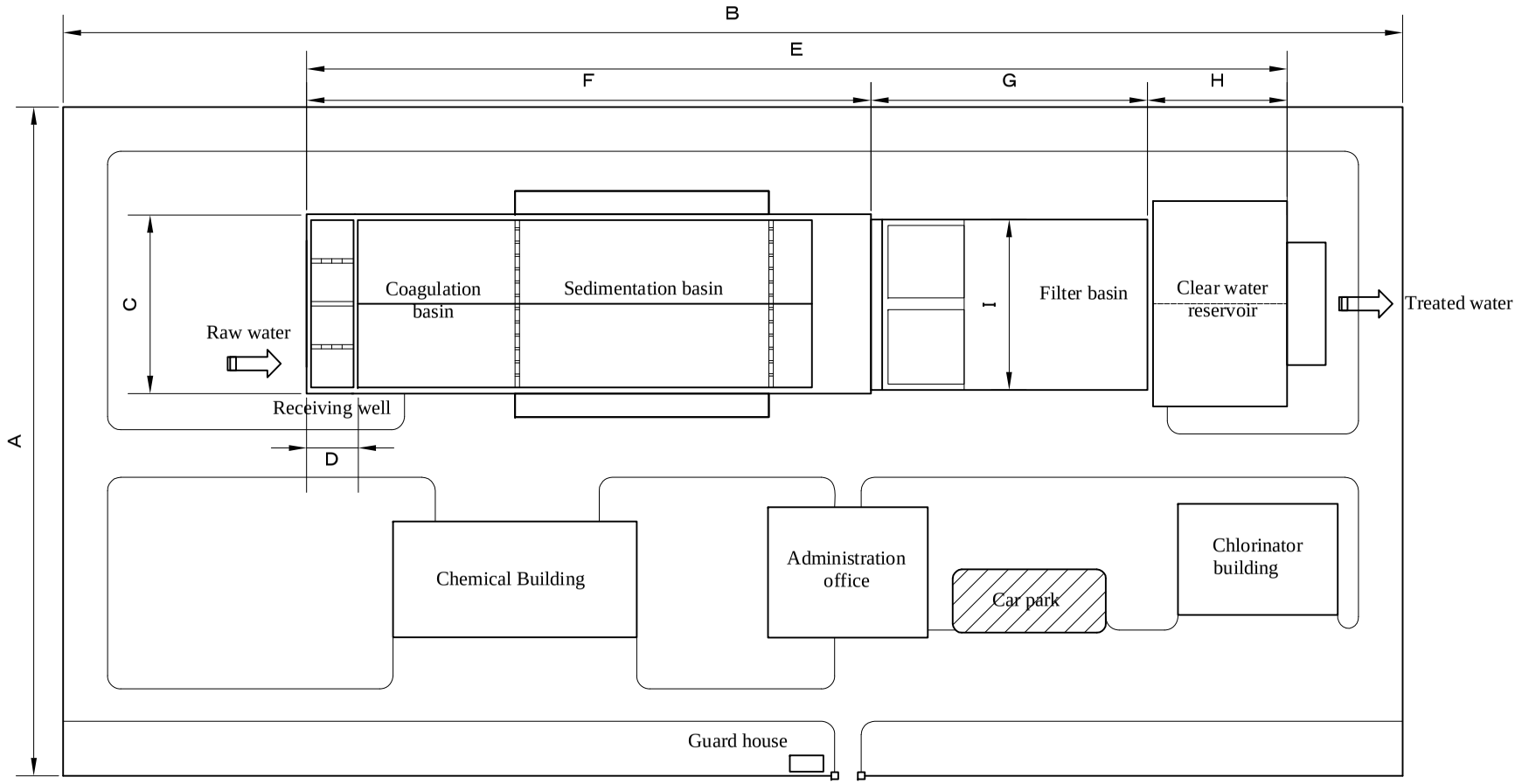
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM

General arrangement of water treatment plant
System FNG-10

Scale : Non

DRW. No.5

ANNEX 3-7

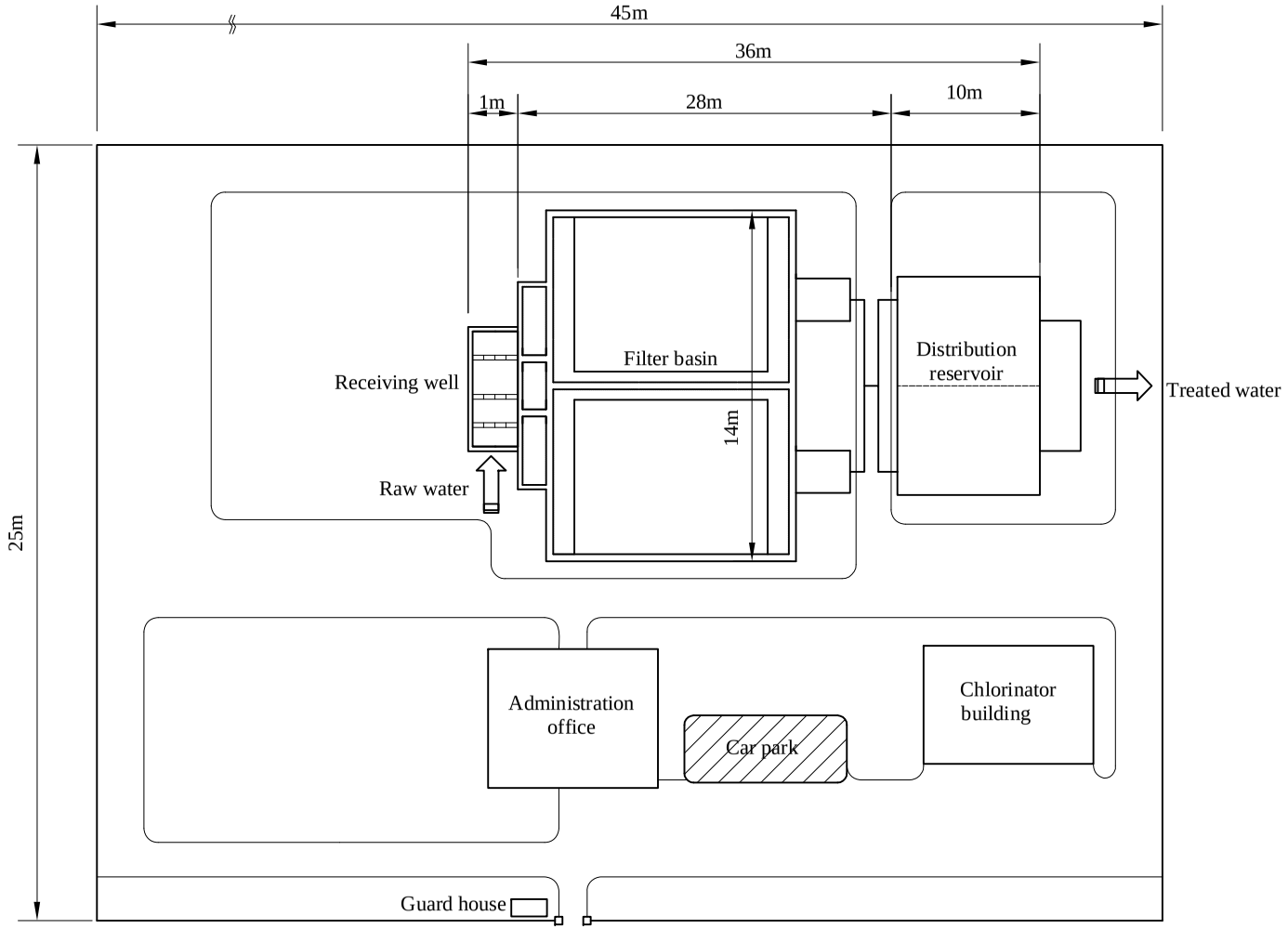


Dimension															
System	Raw water flow capacity (m3/d)	Total dimension		Required Area (m2)	Equipment dimension (m)							Building area (m2)		
		A	B		C	D	E	F	G	H	I	Chemical	Chlorinator	Administration
FBS-11	800	30	50	1,500	6.3	1.4	34.7	16.6	8.1	10.0	6.1	40	25	30

Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	General arrangement of water treatment plant System FBS-11	Scale : Non	DRW. No.6

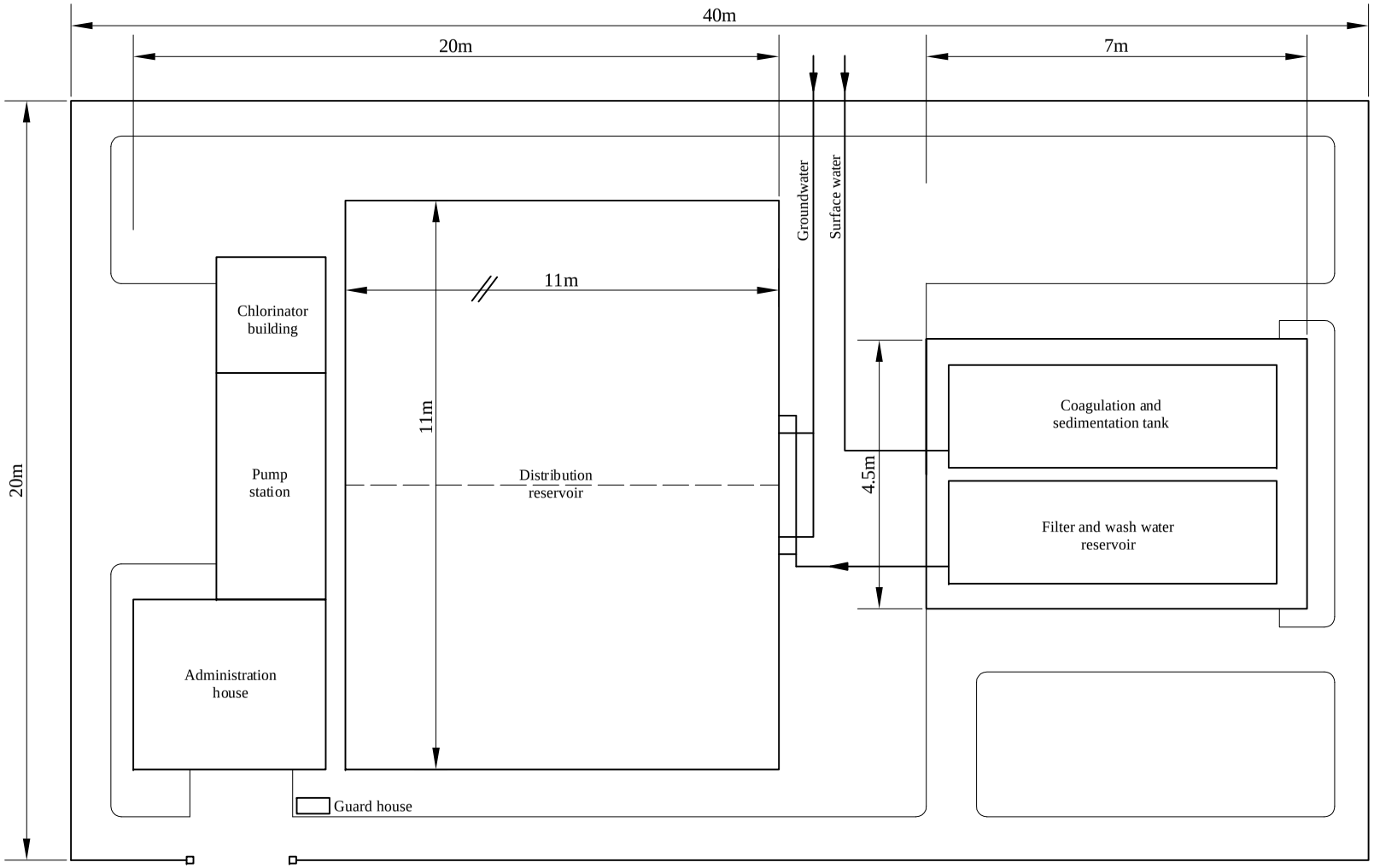
ANNEX 3-8



Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	General arrangement of water treatment plant System FKS-6	Scale : Non	DRW. No.7

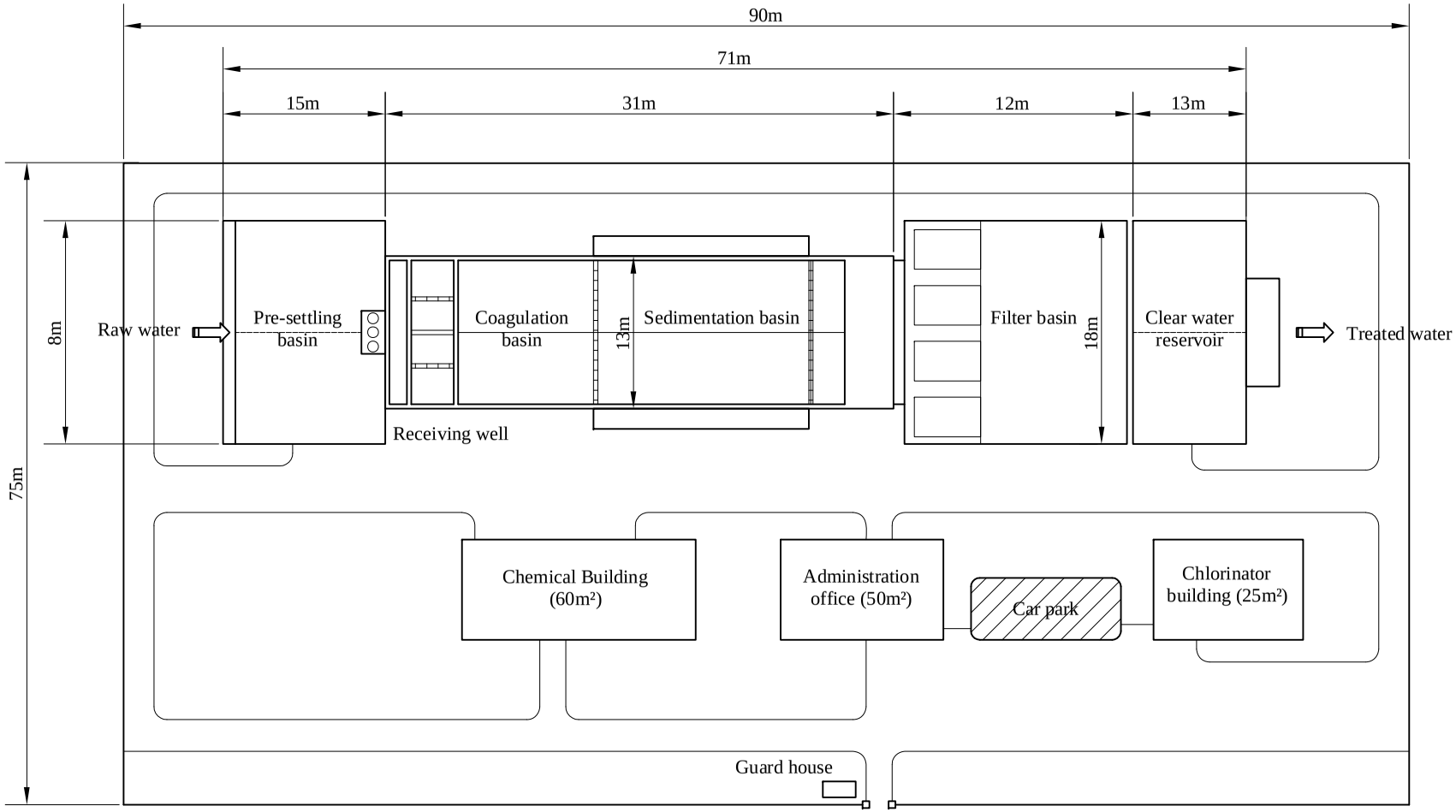
ANNEX 3-9



Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	General arrangement of water treatment plant System FKS-8	Scale : Non	DRW. No.8

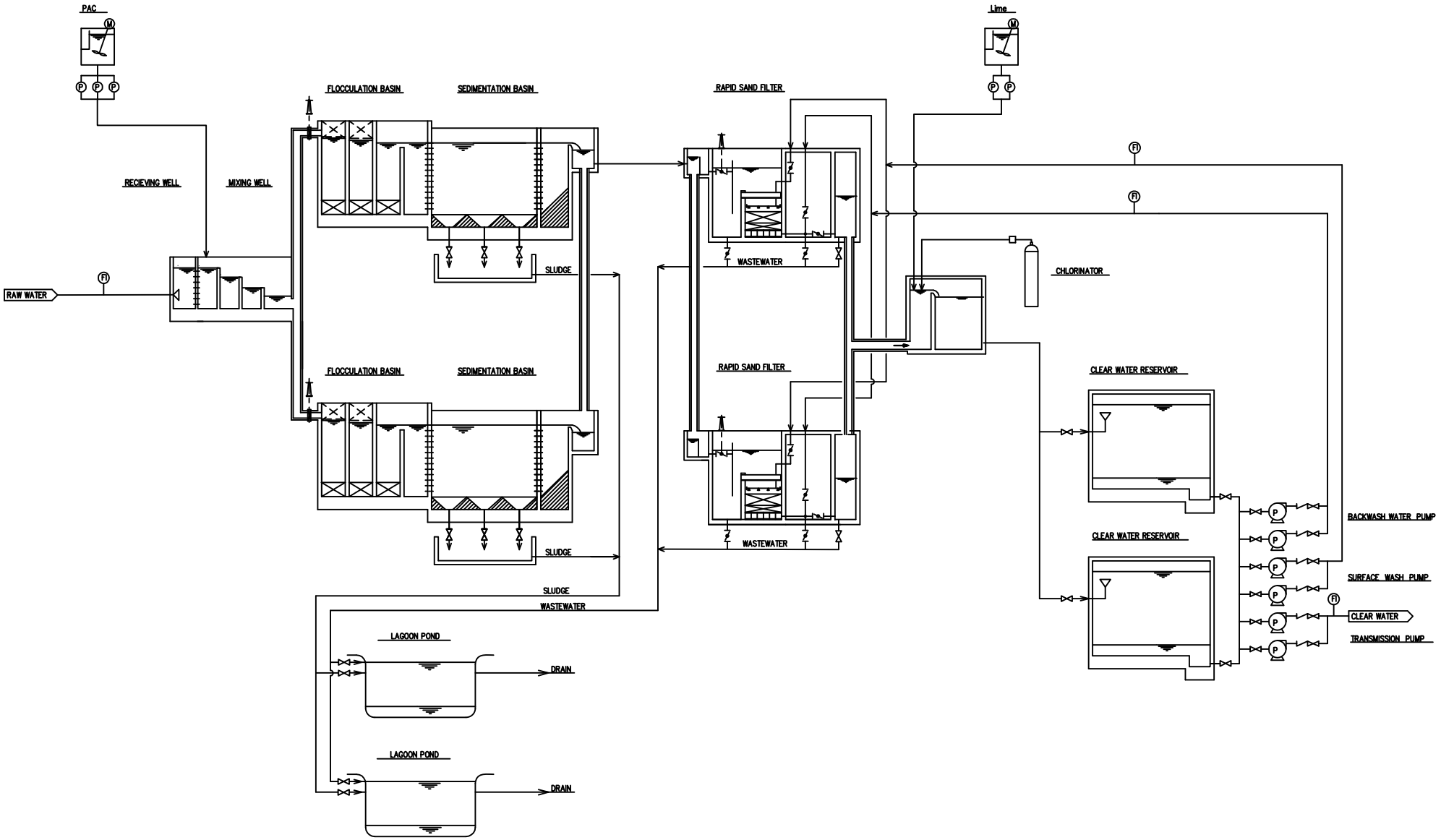
ANNEX 3-10



Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	General arrangement of water treatment plant System FBG-13	Scale : Non	DRW. No.9

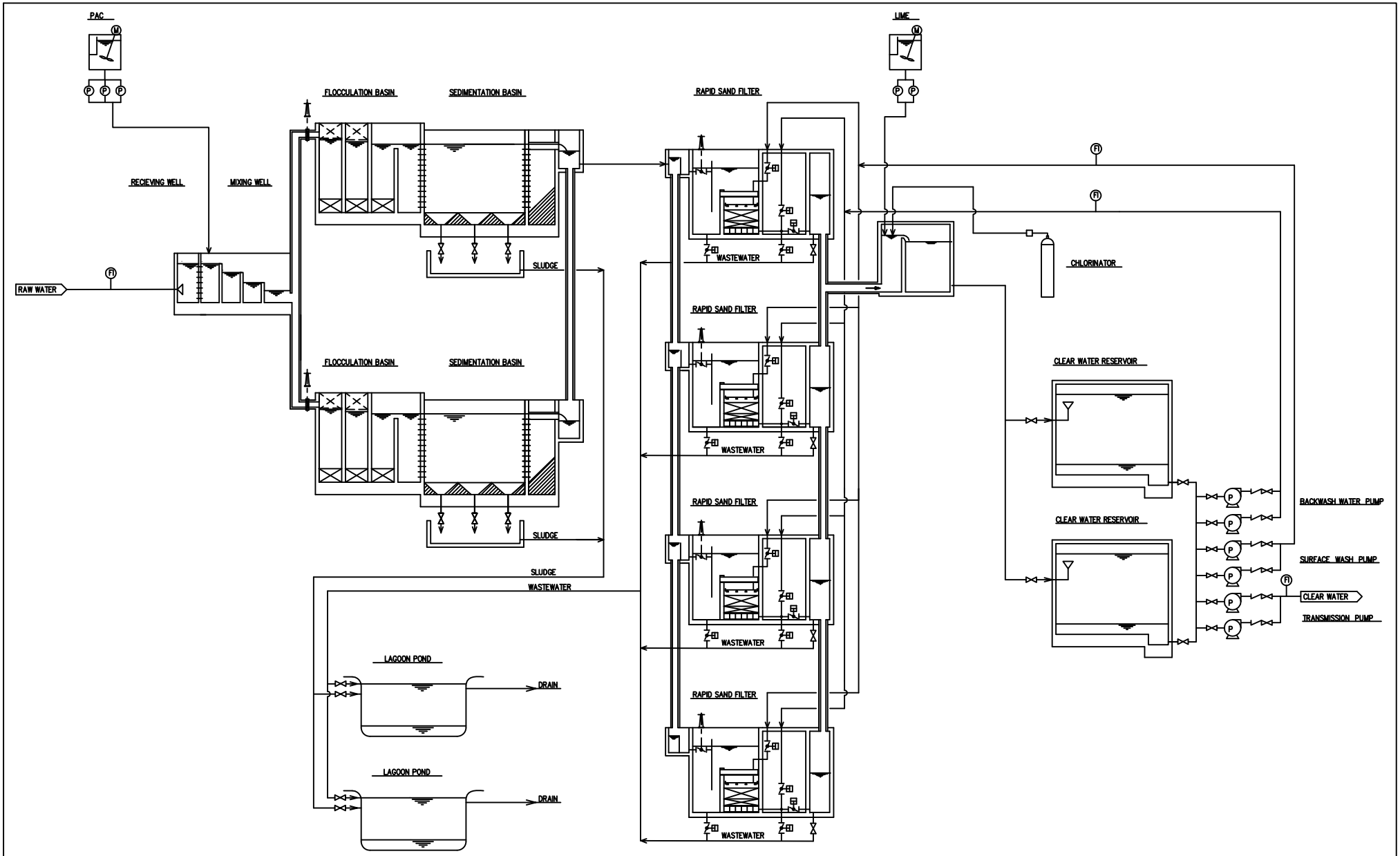
ANNEX 3-11



Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Typical flow sheet System FPS-2, FPG-4, FBS-11	Scale : Non	DRW. No.10

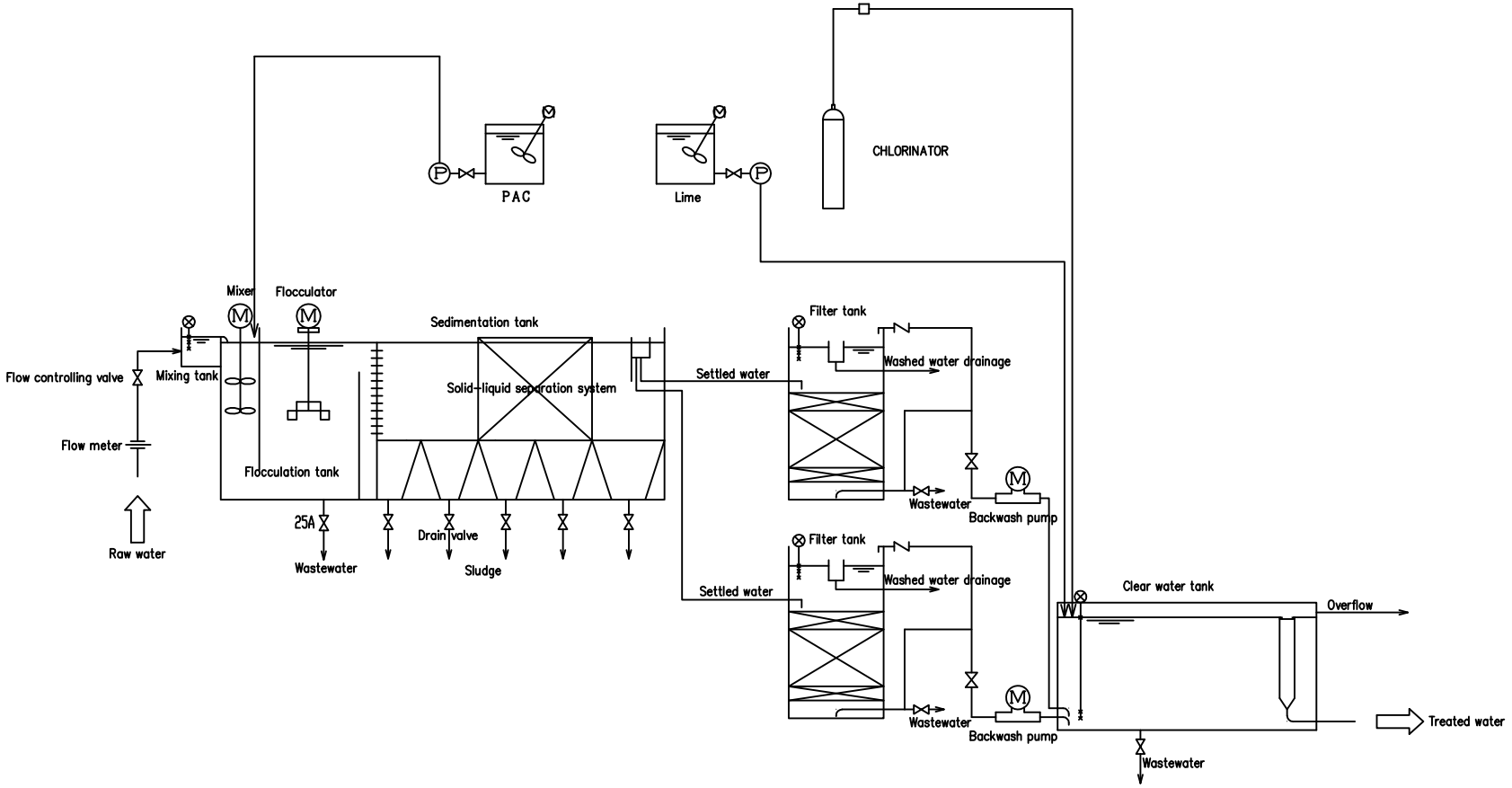
ANNEX 3-12



Preliminary

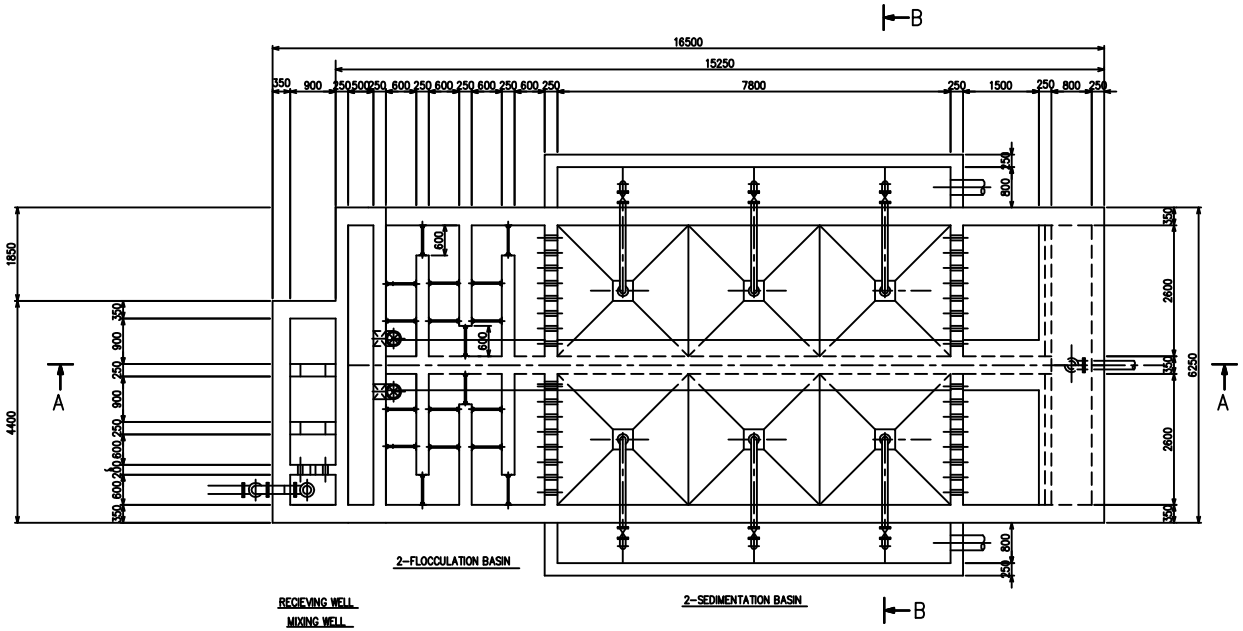
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Typical flow sheet System FNG-10, FBG-13	Scale : Non	DRW. No.11

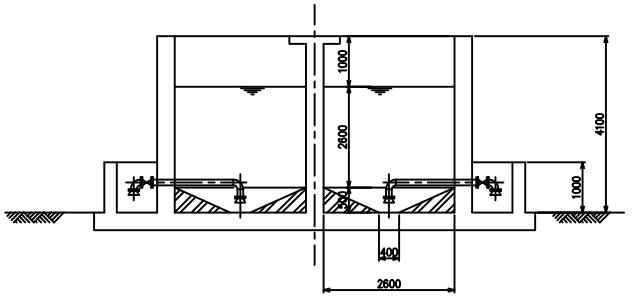
ANNEX 3-13



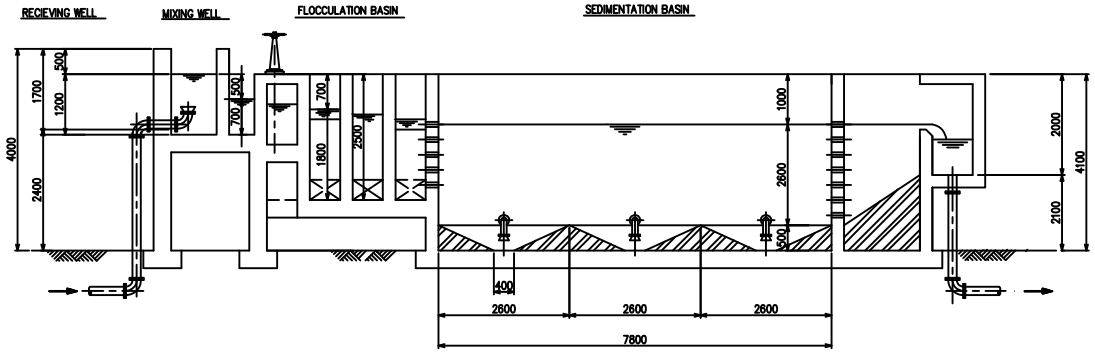
Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Typical flow sheet System FKS-8	Scale : Non	DRW. No.12





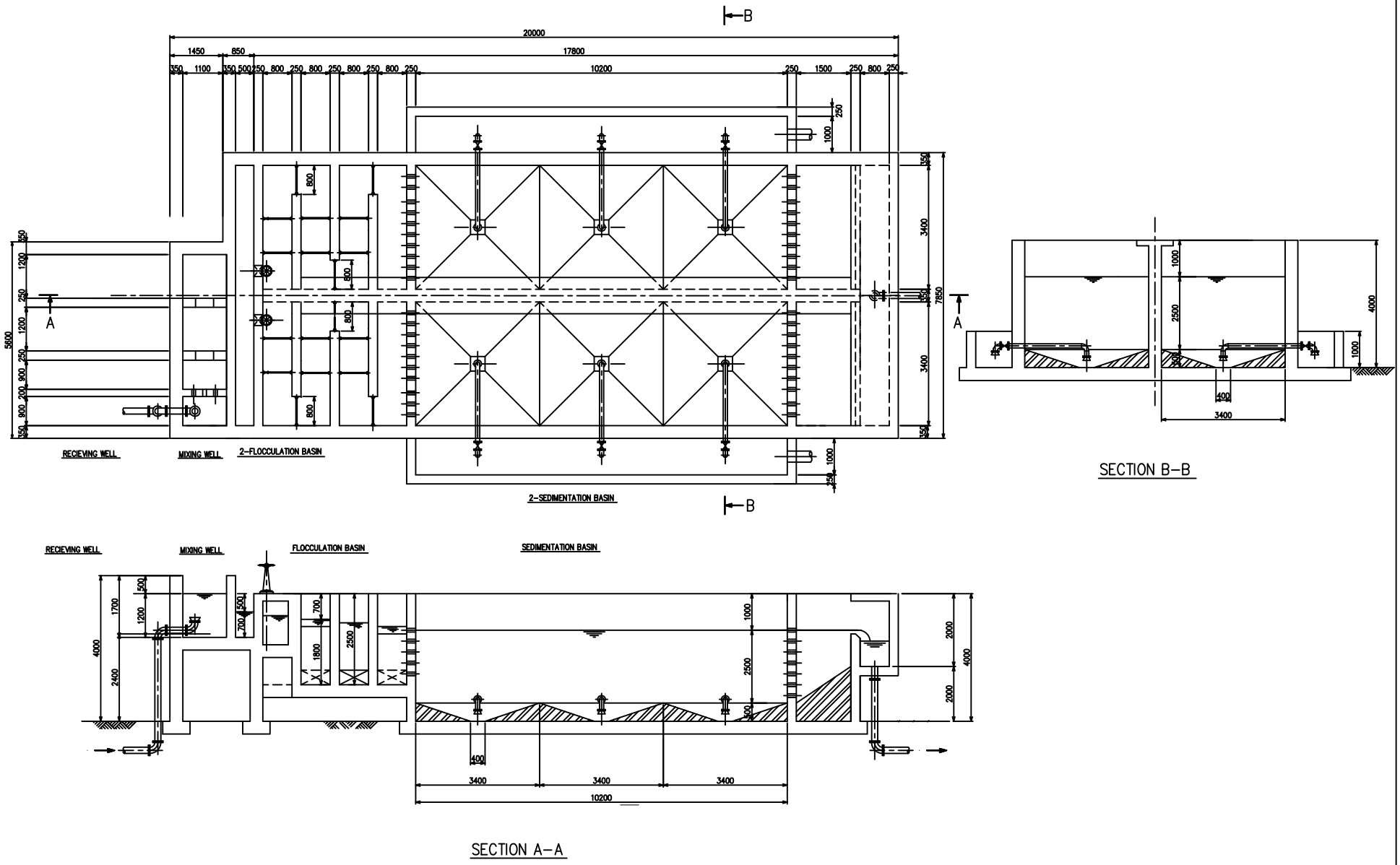
SECTION B–B



SECTION A–A

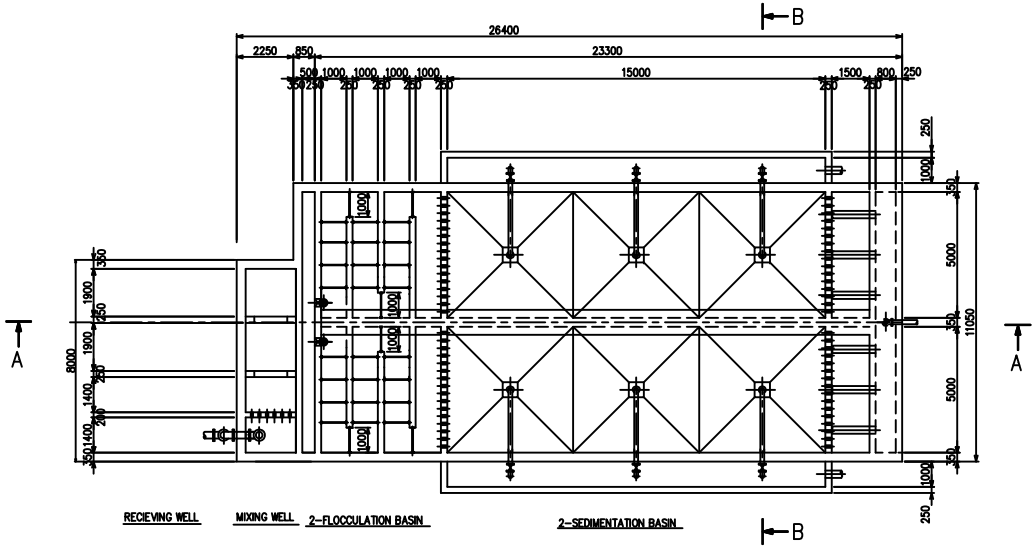
Preliminary

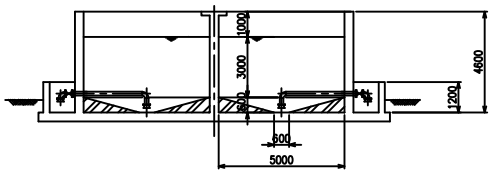
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Sedimentation basin System FPS-2	Scale : 1/150	DRW. No.13



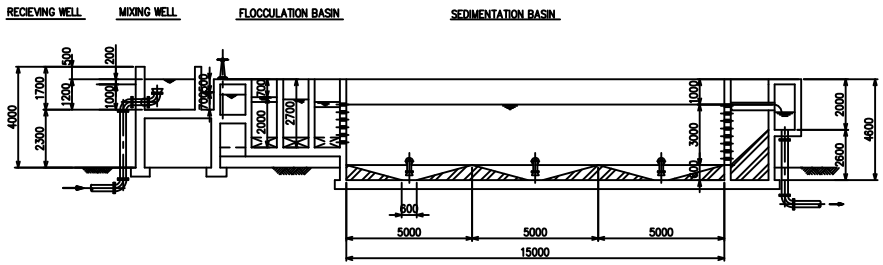
Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Sedimentation basin System FPG-4	Scale : 1/150	DRW. No.14





SECTION B–B

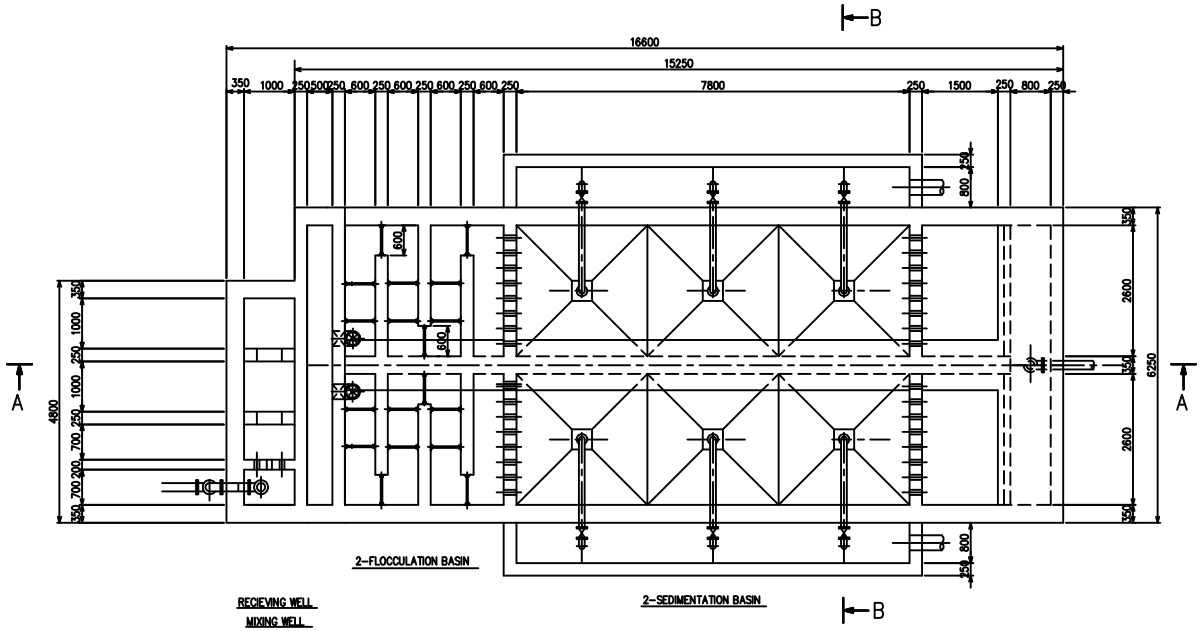


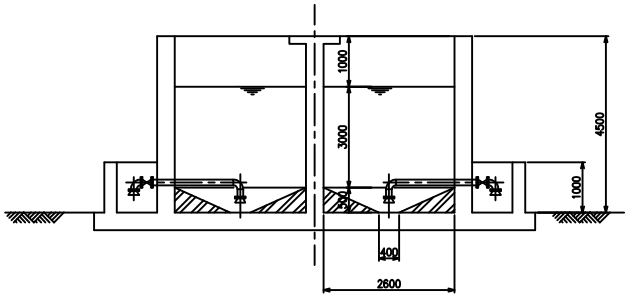
SECTION A–A

Preliminary

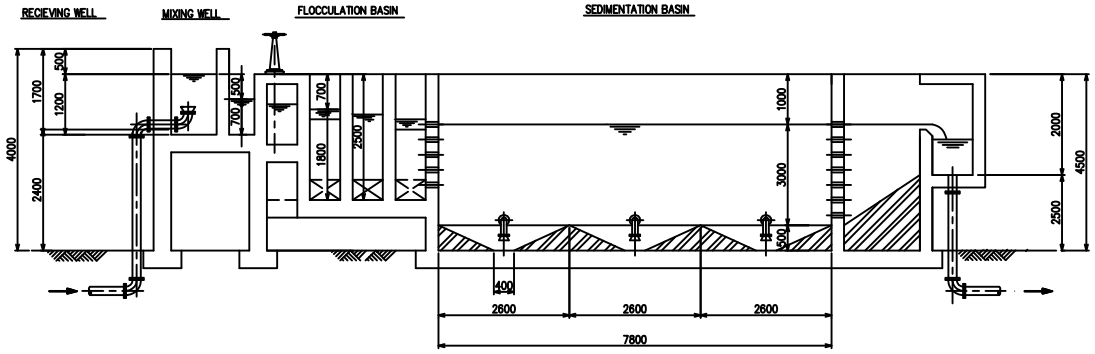
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Sedimentation basin System FNG-10	Scale : 1/300	DRW. No.15

ANNEX 3-17





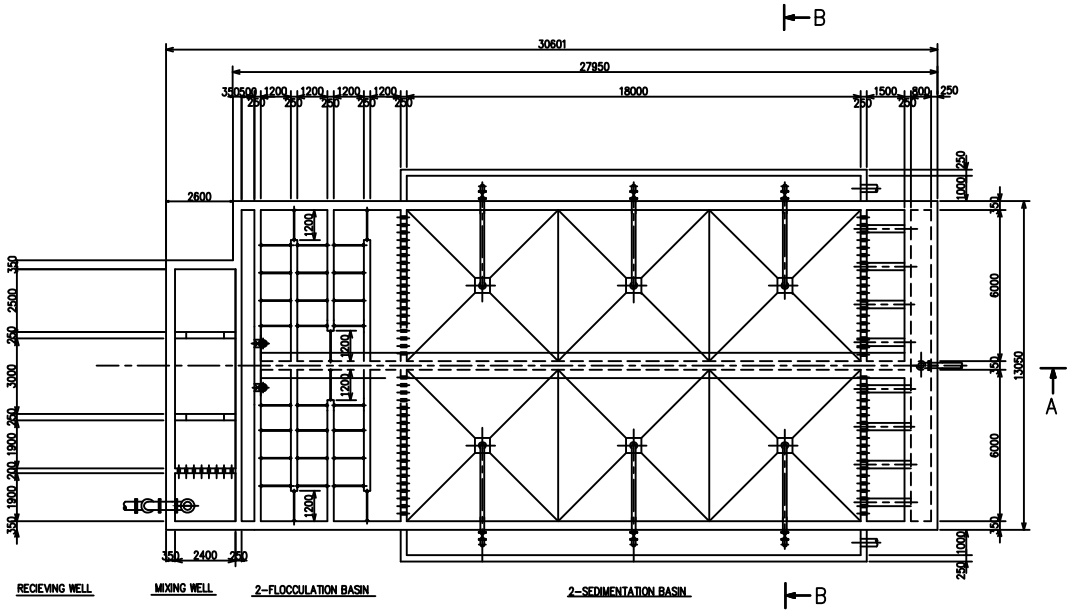
SECTION B–B

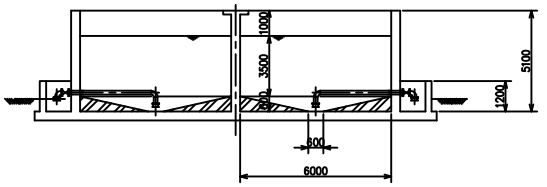


SECTION A–A

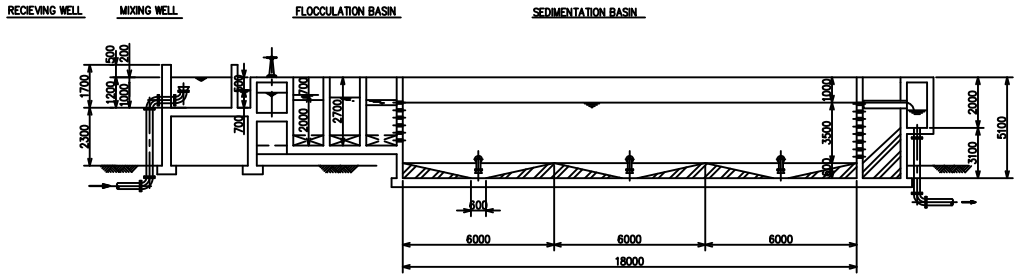
Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Sedimentation basin System FBS-11	Scale : 1/150	DRW. No.16





SECTION B–B

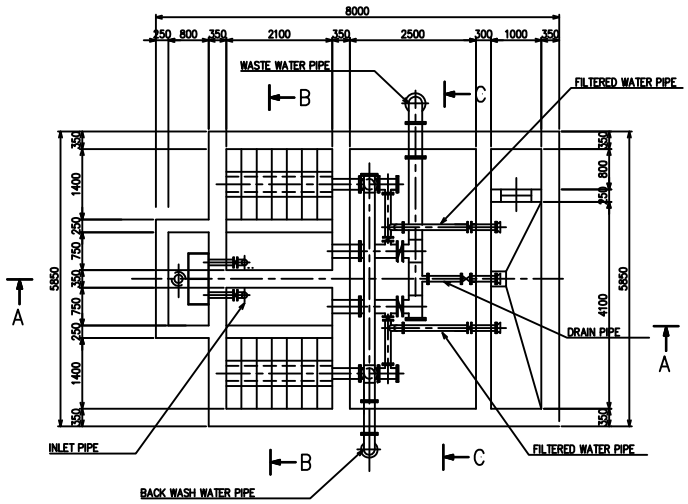


SECTION A–A

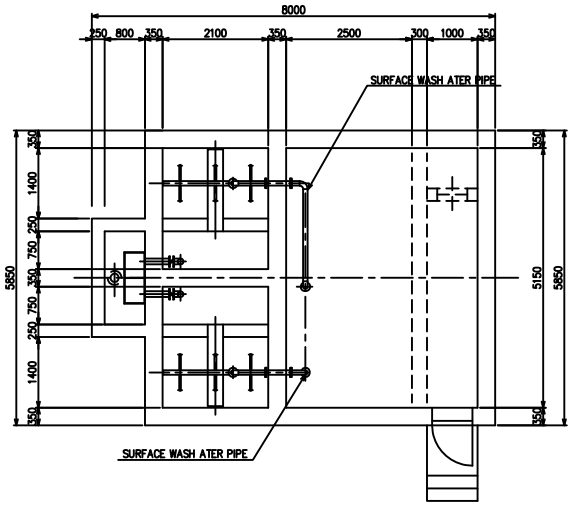
Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Sedimentation basin System FBG-13	Scale : 1/300	DRW. No.17

ANNEX 3-18



PLAN AT B1st FLOOR



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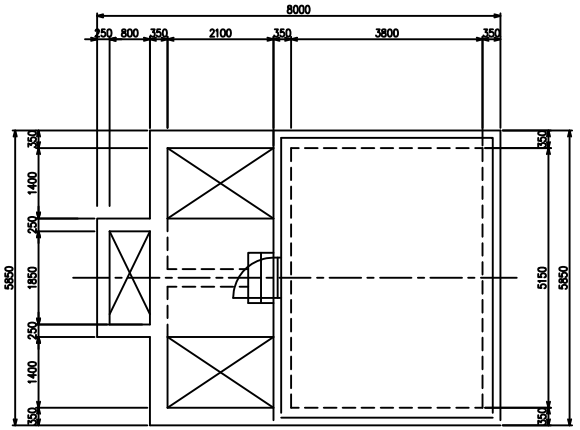
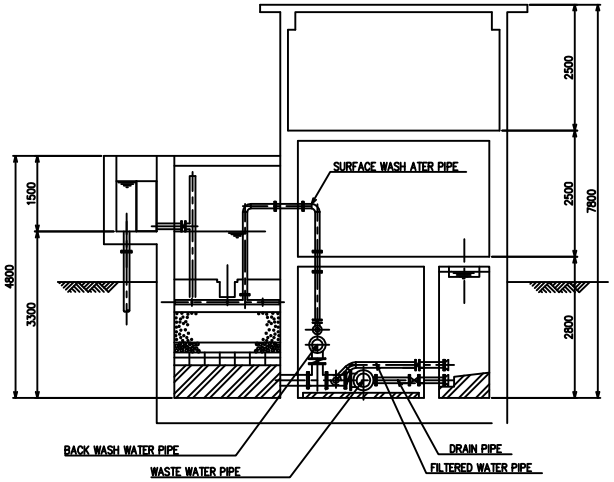
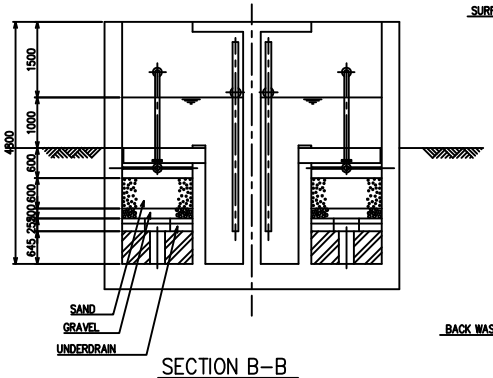


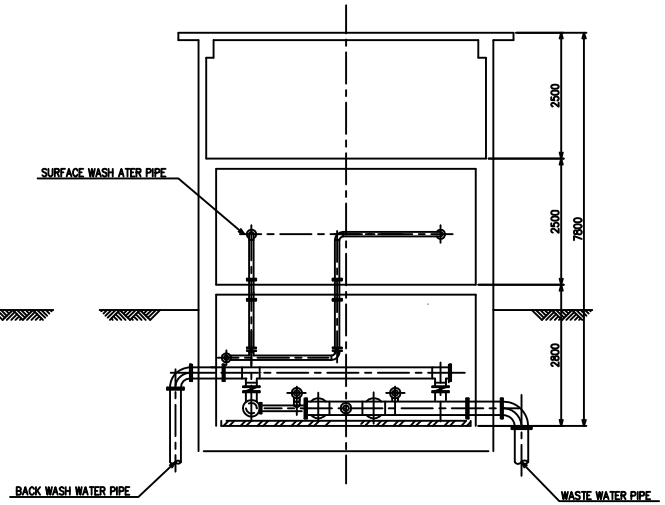
PLAN AT 2nd FLOOR



SECTION A–A



SECTION B–B

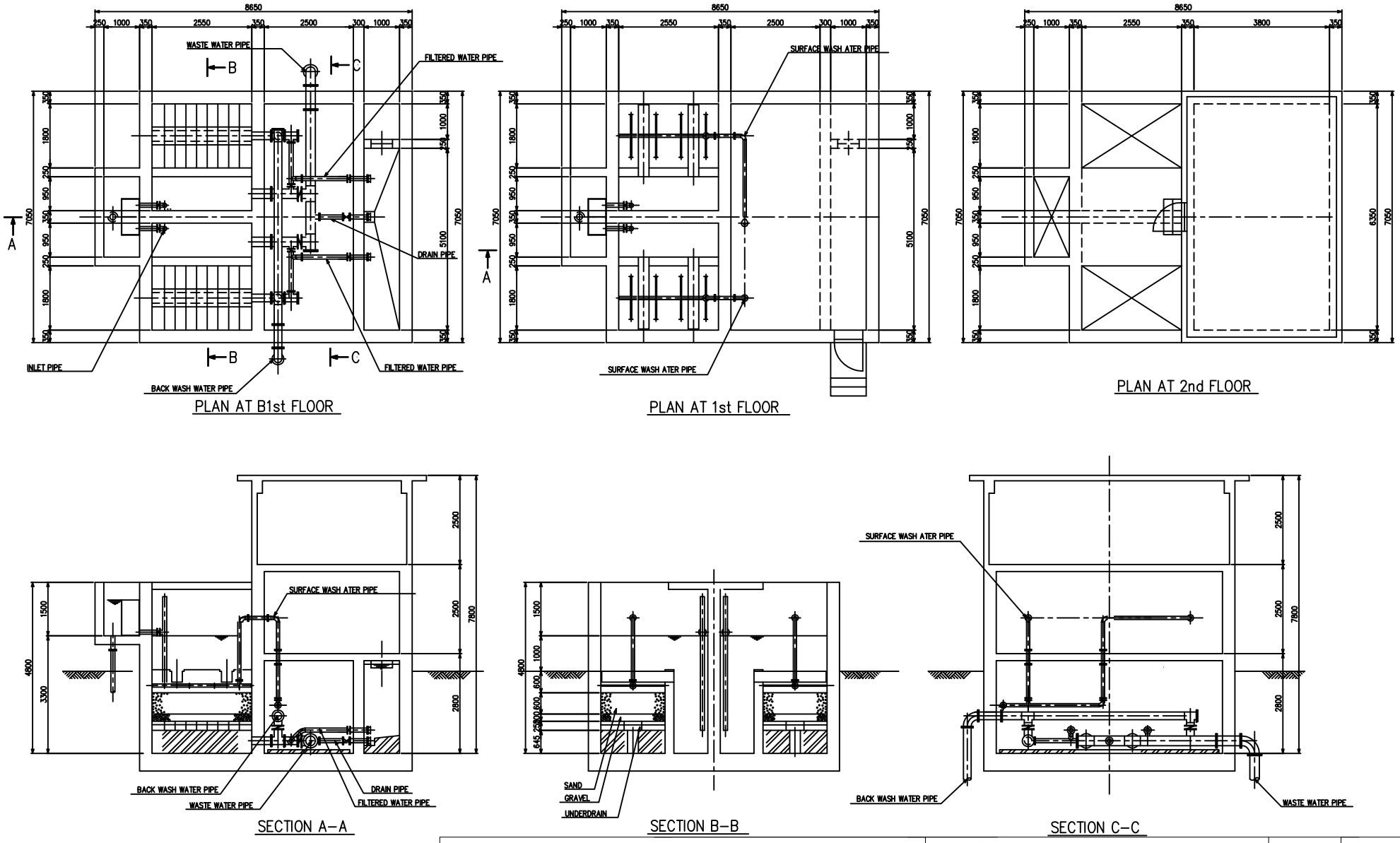


SECTION C–C

Preliminary

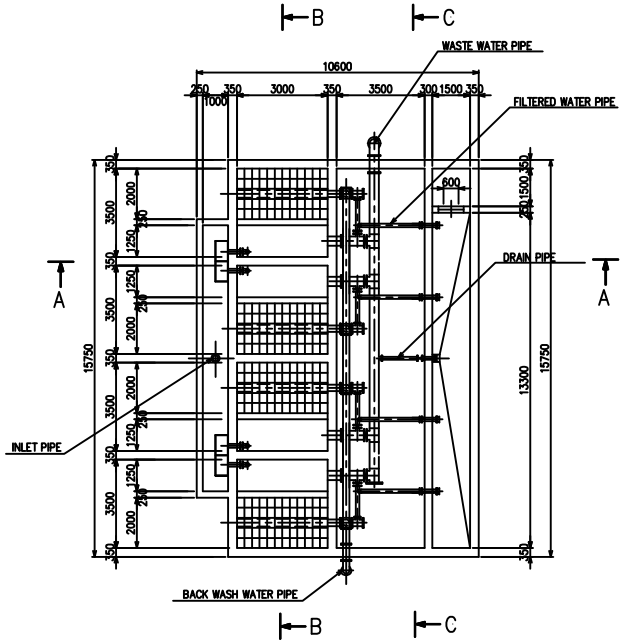
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Rapid sand filter System FPS-2	Scale : 1/150	DRW. No.18

ANNEX 3-20



Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Rapid sand filter System FPG-4	Scale : 1/150	DRW. No.19



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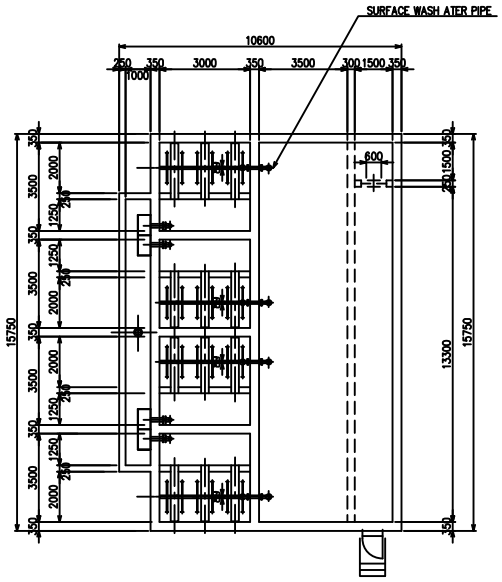
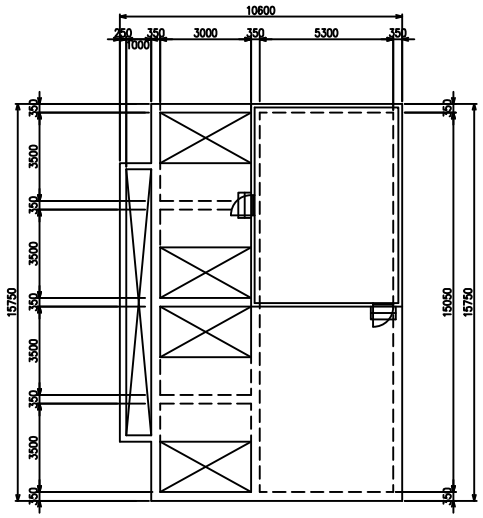
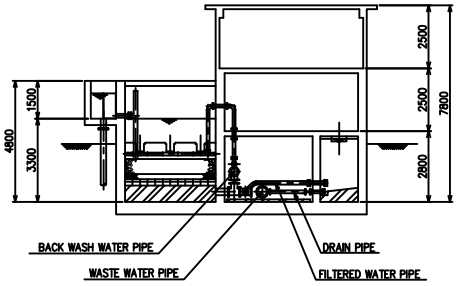


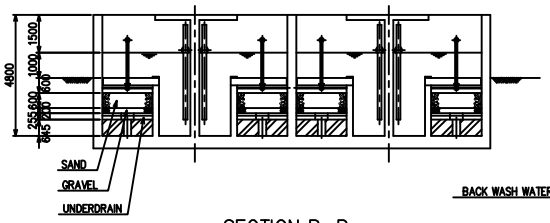
PLAN AT 1st FLOOR



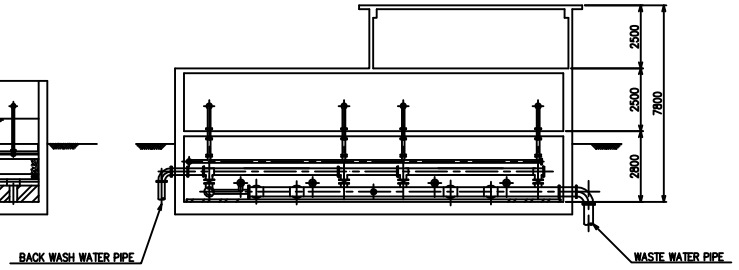
PLAN AT 2nd FLOOR



SECTION A–A



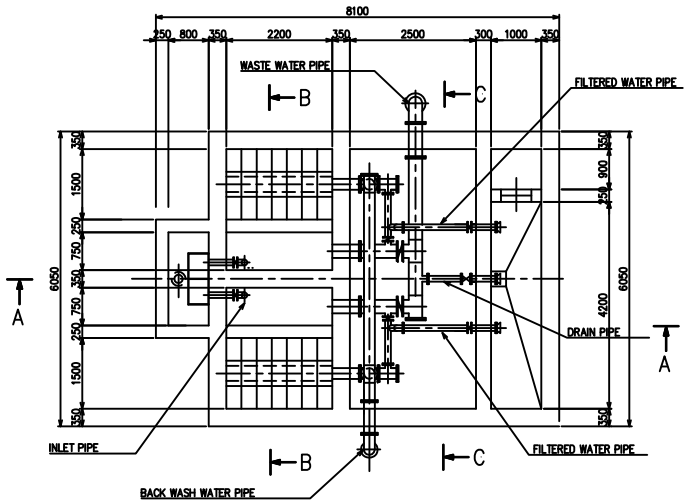
SECTION B–B



SECTION C–C

Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Rapid sand filter System FNG-10	Scale : 1/300	DRW. No.20



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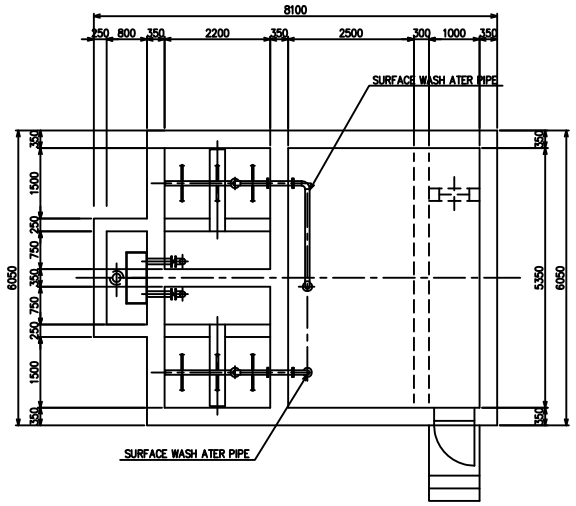

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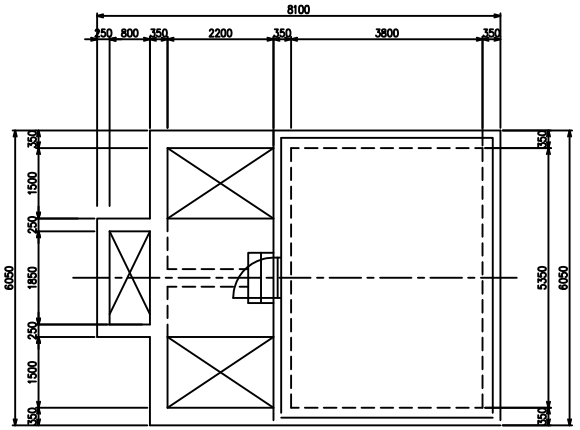

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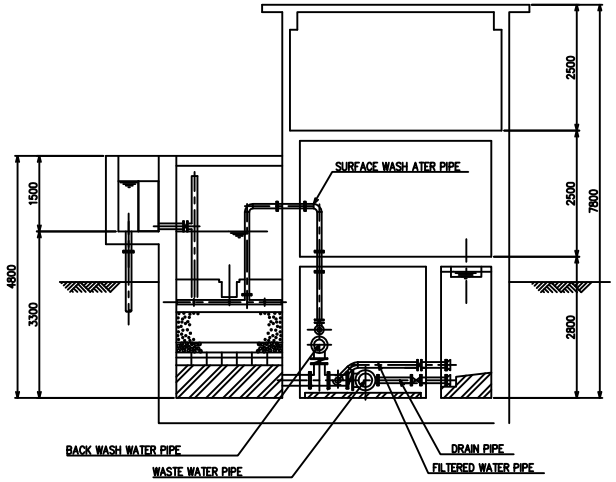
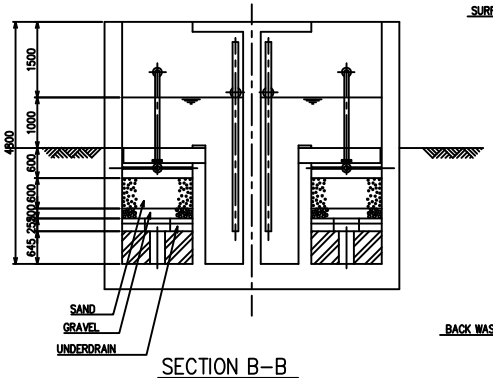


SECTION A–A



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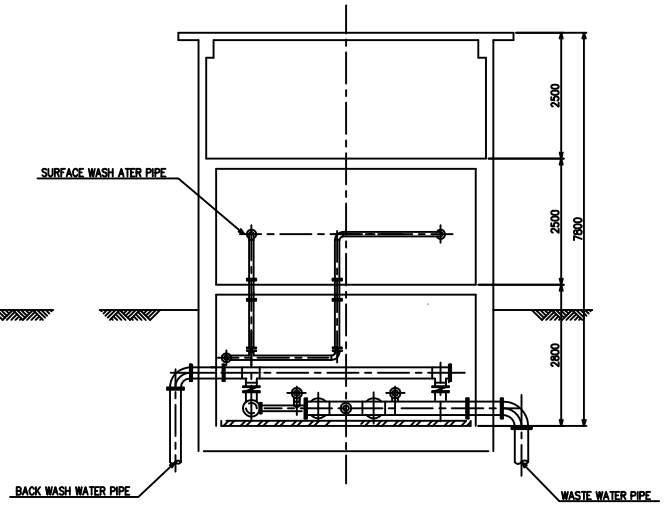
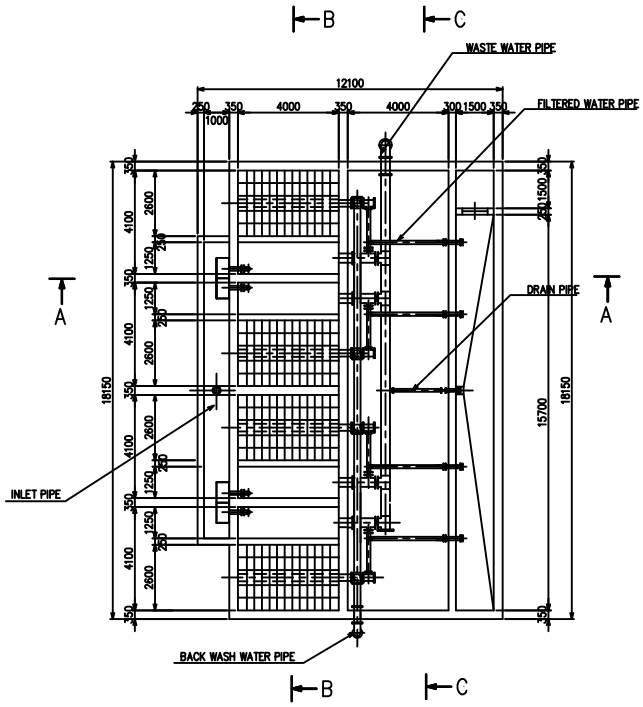


SECTION C–C

Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Rapid sand filter System FBS-11	Scale : 1/150	DRW. No.21



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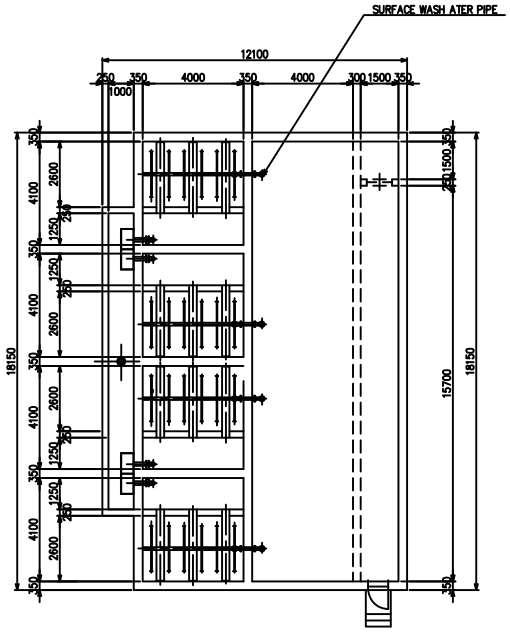
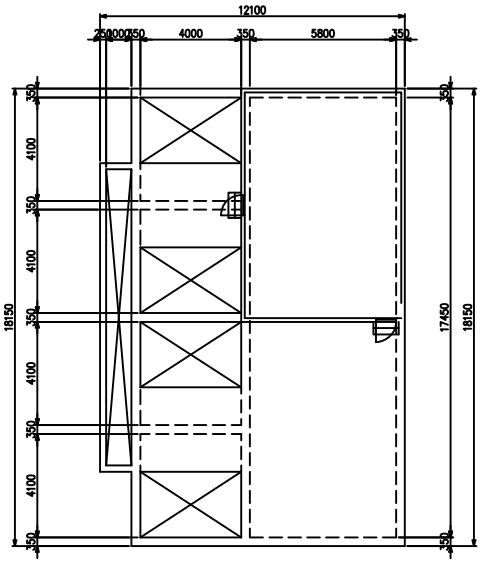


PLAN AT 1st FLOOR



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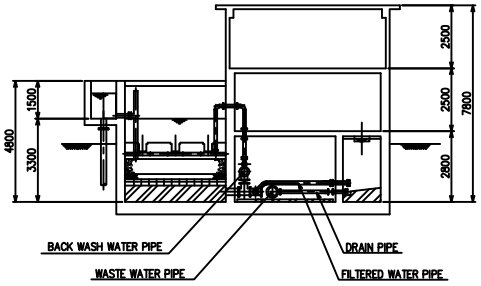
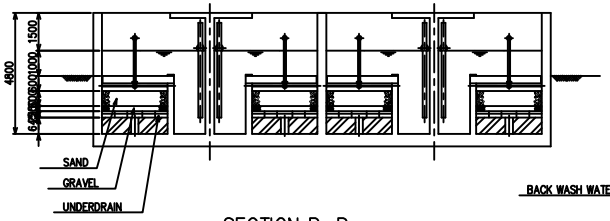


SECTION A–A



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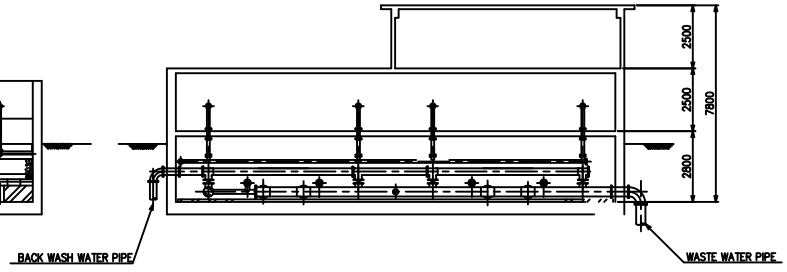
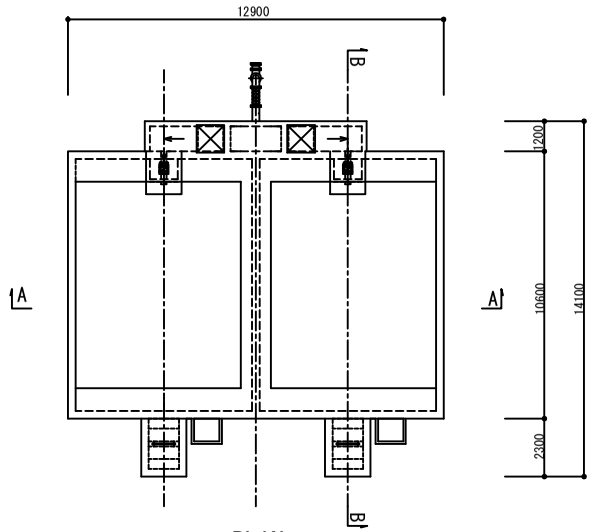


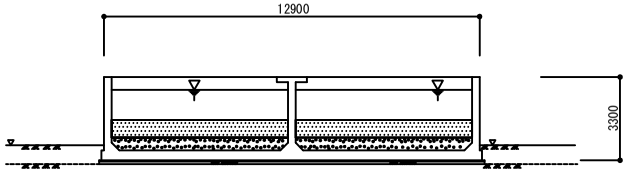
SECTION C–C

Preliminary

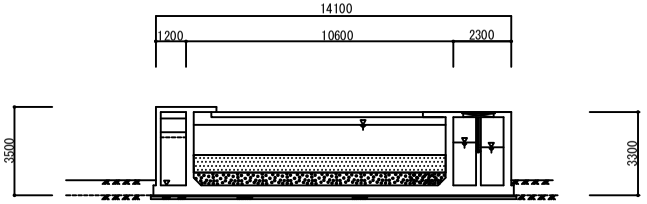
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Rapid sand filter System FBG-13	Scale : 1/300	DRW. No.22



PLAN
1:200



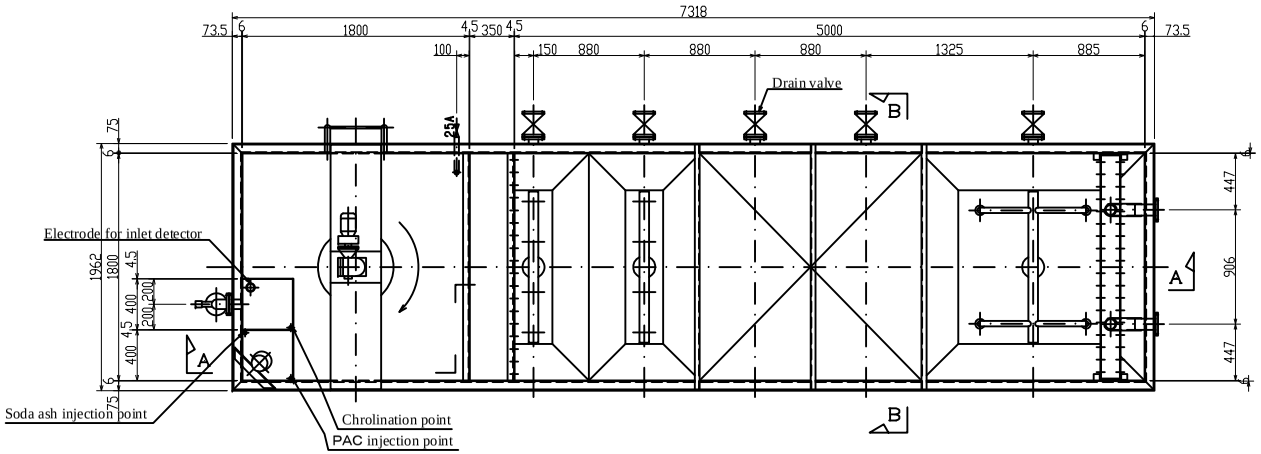
SECTION A-A
1:200



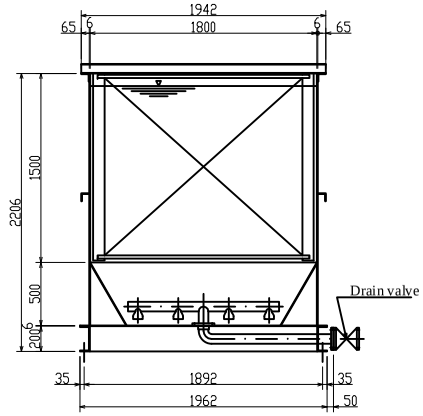
SECTION B-B
1:200

Preliminary

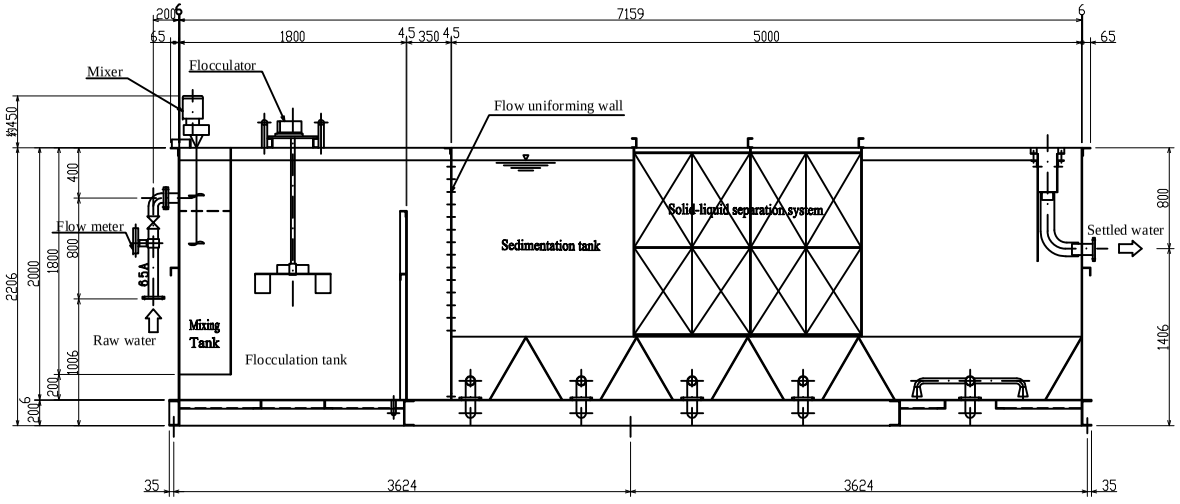
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Slow sand filter System FKS-6	Scale : 1/300	DRW. No.23



PLAN



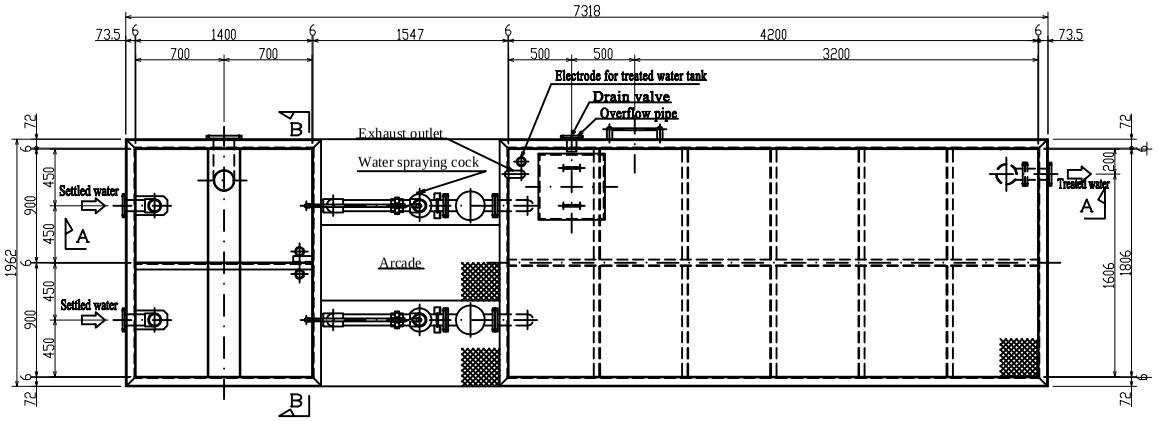
B-BSECTION



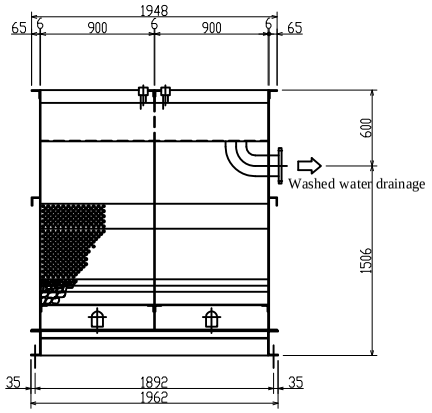
A-ASECTION

Preliminary

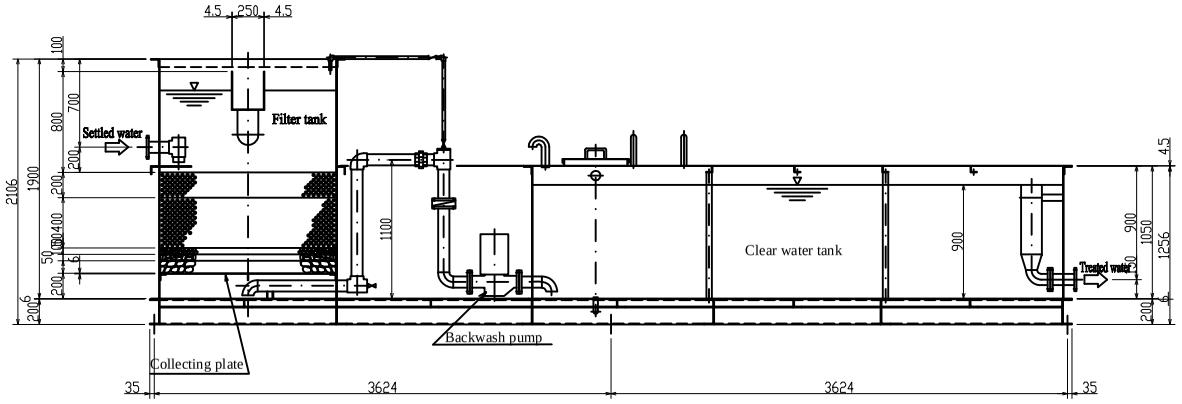
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Compact water treatment unit Coagulation and sedimentation tank System FKS-8	Scale : 1/60	DRW. No.24



PLAN



B – B SECTION



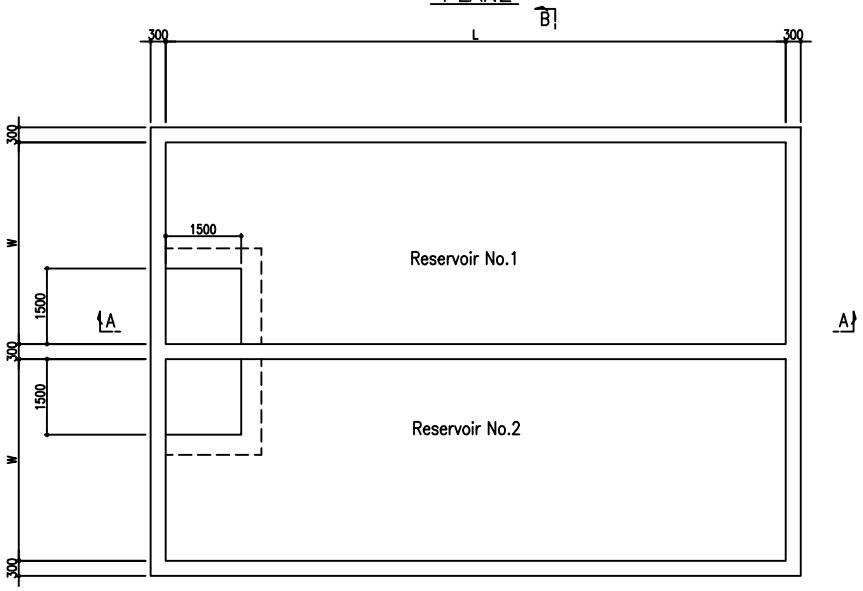
A – A SECTION

Preliminary

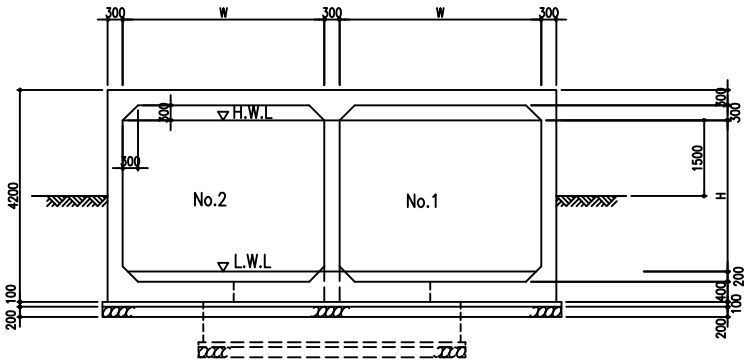
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Compact water treatment unit Filter and clear water tank System FKS-8	Scale : 1/60	DRW. No.25

RESERVOIR (Type−1)

PLANE

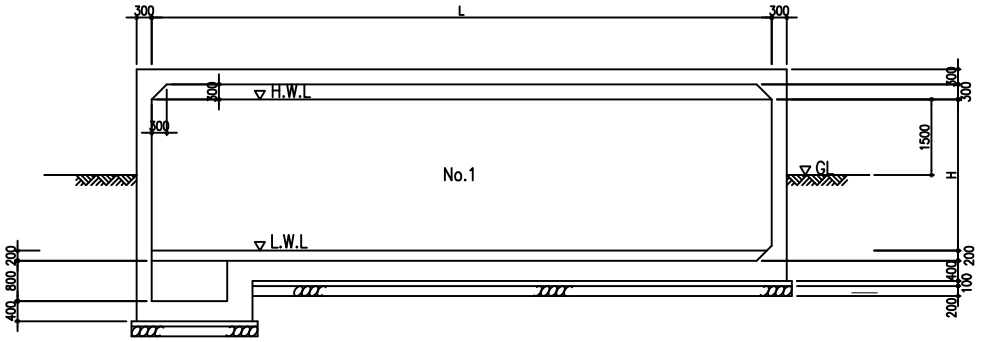


SECTION B − B



B

SECTION A − A



Dimension

Sysem	Design capacity (m3)	Dimension				Number	Capacity
		W(m)	L(m)	He(m)	H(m)		
FPS−2	200	4.5	7.5	3.0	3.5	2	203
FPS−3	400	4.5	15.0	3.0	3.5	2	405
FPG−4	19	2.0	3.0	2.0	2.5	2	24
FPS−5	267	4.5	10.0	3.0	3.5	2	270
FKS−6	250	4.5	8.5	3.0	3.5	2	257
FKS−8	254	4.5	9.5	3.0	3.5	2	257
FNG−10	390	5.0	13.0	3.0	3.5	2	390
FBS−11	300	4.5	10.0	3.5	3.5	2	315
FBG−13	348	4.5	13.0	3.0	3.5	2	351

Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM

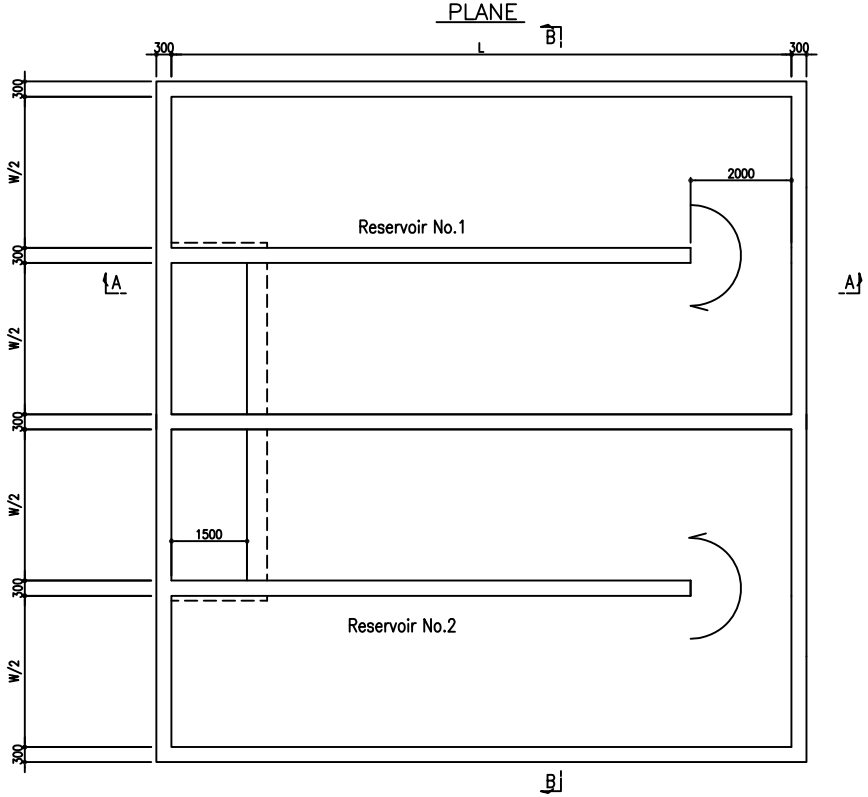
Distribution reservoir (Type-1)

Scale : 1/150

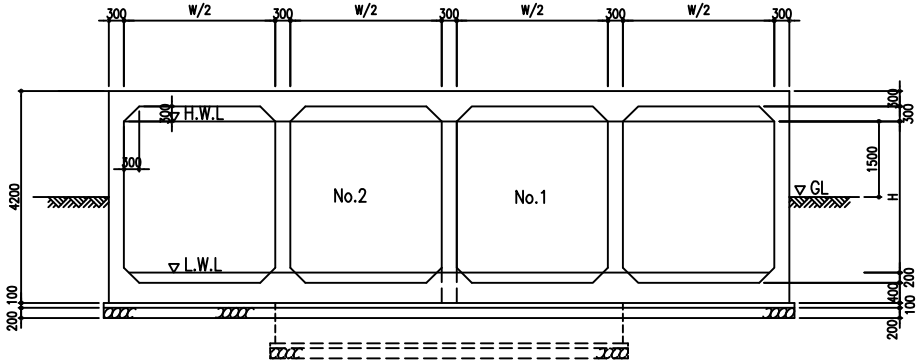
DRW. No.26

RESERVOIR (Type-2)

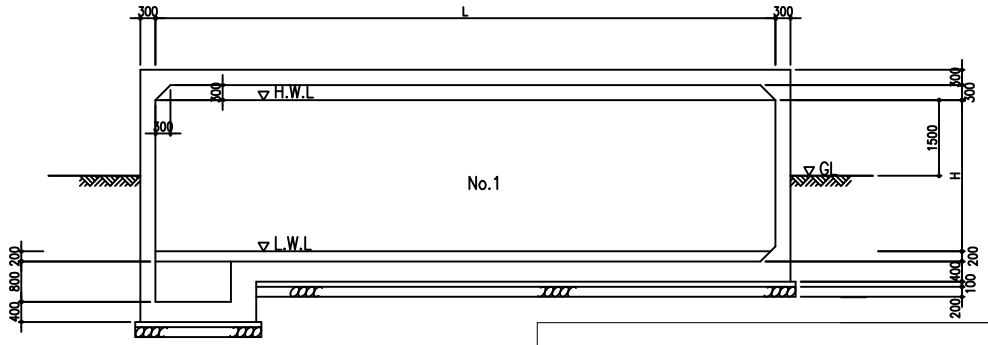
PLANE



SECTION B – B



SECTION A – A



Dimension

System	Design capacity (m3)	Dimension				Number	Capacity
		W(m)	L(m)	He(m)	H(m)		
FBG–13	1,152	8.0	18.0	4.0	4.5	4	1,152

Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM

Distribution reservoir (Type-2)

Scale : 1/150

DRW. No.27

ANNEX 4 SHEET FOR DETAILS OF THE ACTION PLAN

CENTRAL- Cerwass

Sheet for Details of the action plan
Chi tiết kế hoạch thực hiện

Objectives: Capacity development
Mục tiêu:

Expected Outcome: ***Formation of Capacity development plan***
Kết quả mong muốn:

Organization and management responsibility: ***Technical Department Chief of N-Cerwass***
Nhiệm vụ tổ chức và quản lý:

Action Plan Worksheet
Bảng kế hoạch thực hiện

No. ***Stt***	**Activity to be carried out** ***Những việc cần làm***	**Monitoring performance** ***Theo dõi quá trình thực hiện***	**Estimated costs (USD)** ***Chi phí dự tính (USD)***	**Inputs and Resources required** ***Nguồn đầu vào được yêu cầu***	**Due Date** ***Ngày hoàn thành***
	-To train, to enhance managerial capacity in water supply for central staffs	- Defining target, requiring to increase capacity, holding training courses		- Experienced expert in training and management - Budget for training	.2008
	-To train the management and operation of WSS for provincial technical staffs	-Setting up training plan, informing training results.		- Related documents	2008-2010
	-To train, to guide and to propagandize….for managers and operators at WSS				
	-To control water quality	- Guiding on applying legal regulations and monitoring (of progress??)		-Legal frame -Human resources -Budget	

Phu Yen P-Cerwass
Sheet for Details of the action plan
Chi tiết kế hoạch thực hiện

Objectives: ***Capacity development***
Mục tiêu:

Expected Outcome: ***Forming capacity development plan***
Kết quả mong muốn:

Organization and management responsibility: ***IEC-Technical staff/cadre***
Nhiệm vụ tổ chức và quản lý:

Action Plan Worksheet
Bảng kế hoạch thực hiện

No. ***Stt***	**Activity to be carried out** ***Những việc cần làm***	**Monitoring performance** ***Theo dõi quá trình thực hiện***	**Estimated costs (USD)** ***Chi phí dự tính (USD)***	**Inputs and Resources required** ***Nguồn đầu vào được yêu cầu***	**Due Date** ***Ngày hoàn thành***
01	- To support technique for surveying and investigating and ground water source	-Transferring technology, monitoring water level changes.			-06/2008
02	-To train managers, especially basic level staffs	-Holding long-term or short-term training course			10/2009
03	-To have guidance policy of higher level on unifying all WSS managed by P-CERWASS				12/2009
04	-To equip and support water quality testing lab.	- To evaluate water quality every month or every period			12/2008
05	-Enhance facilities and managerial staff by diversifying training forms and developing training centre of the province				10/2010

Khanh Hoa P-Cerwass
Sheet for Details of the action plan
Chi tiết kế hoạch thực hiện

Objectives: ***Capacity development***
Mục tiêu:

Expected Outcome: ***Formation of capacity development plan***
Kết quả mong muốn:

Organization and management responsibility: ***Khanh Hoa Director***
Nhiệm vụ tổ chức và quản lý:

Action Plan Worksheet
Bảng kế hoạch thực hiện

No. ***Stt***	**Activity to be carried out** ***Những việc cần làm***	**Monitoring performance** ***Theo dõi quá trình thực hiện***	**Estimated costs (USD)** ***Chi phí dự tính (USD)***	**Inputs and Resources required** ***Nguồn đầu vào được yêu cầu***	**Due Date** ***Ngày hoàn thành***
1/	*Assignment of management and exploitation for gathering water-works so that: -Water center can manage big water-works to serve 2 communes up. -Localities manage water works for their commune.	- PPC's decision - Ministry of agriculture guides by circular -Guideline carried out by PPC			. -2009-2010
2/	*Increasing the investment capital source from the government, province, and social activities to built water-works that raises population rate served with clean water to 20-85%	- Investment planning of MARD - Investment planning of the province -Other capital source	50 billion VND		2008-2010
3/	*Completion of mechanism, management policy and water tariff	-PPC's decision	100 million VND		2008-2009
4/	*Training planning Cadres manage annually (2-5days/course)	PPC's decision	300 million VND/year		2008-2010

Ninh Thuan P-CERWASS
Sheet for Details of the action plan
Chi tiết kế hoạch thực hiện

Objectives: ***Competence development***
Mục tiêu:

Expected Outcome: ***The plan for capacity development***
Kết quả mong muốn:

Organization and management responsibility: ***Director of Ninh thuan P-CERWASS***
Nhiệm vụ tổ chức và quản lý:

Action Plan Worksheet
Bảng kế hoạch thực hiện

No. ***Stt***	**Activity to be carried out** ***Những việc cần làm***	**Monitoring performance** ***Theo dõi quá trình thực hiện***	**Estimated costs (USD)** ***Chi phí dự tính (USD)***	**Inputs and Resources required** ***Nguồn đầu vào được yêu cầu***	**Due Date** ***Ngày hoàn thành***
1.	Upgrade and repair WSSs that don't ensure quality	Annually, plan to repair 3-4 systems	2 million USD	Decision of PPC	.2010
2.	Transfer some WSSs that are not managed effectively to P-CERWASS	Annually, receive 2-3 systems	1 million USD	Decision of PPC	2010
3.	Set up water tariff frame for each system, each area. Have water tariff policy for poor people	Have adjustment every 2 or 3 years	10,000 USD	Through people's council, have decision of PPC	Adjustment every 2 or 3 years
4.	Have managerial staffs and operators trained	Have 2 – 3 training classes every year	200,000 USD	Decision of PPC	Implement every year
5.	Strengthen communication to users	Annually, have 4-5 classes	200,000 USD	Decision of PPC	Implement every year
6.	Reinforce organization for each WSS	Depending on annual recruitment need, recruit 10-20 people	100,000 USD	Decision of P-CERWASS	Implement every year

Binh Thuan P-cerwass
Sheet for Details of the action plan
Chi tiết kế hoạch thực hiện

Objectives: ***capacity development***
Mục tiêu:
Expected Outcome: ***Implementation of capacity development plan***
Kết quả mong muốn:
Organization and management responsibility: ***P-CERWASS Director***
Nhiệm vụ tổ chức và quản lý:

Action Plan Worksheet
Bảng kế hoạch thực hiện

No. ***Stt***	**Activity to be carried out** ***Những việc cần làm***	**Monitoring performance** ***Theo dõi quá trình thực hiện***	**Estimated costs (USD)** ***Chi phí dự tính (USD)***	**Inputs and Resources required** ***Nguồn đầu vào được yêu cầu***	**Due Date** ***Ngày hoàn thành***
1.	- Keeping on applying the Quality Management System ISO 9001-2000 (Promotion and Development)	- Annually Examining And Monitoring	3,000	- Evaluating expert of ISO Consulting Unit	- Annually
2	- Employment by competitive exams (applied for trained candidates)	-About 20 – 25 Employees Recruited Annually	25,000		- Annually
3	- Enhancing training and examining operators' ability	- About 2 – 3 courses annually	5,000	- CERWASS - Domestic experts - Universities and Colleges	- Annually; WSS with 10,000 m^3/day alone estimated in 2012
4.	- Continuing the gathering management for newly-completed WSS as well as Town-scaled WSS (3000 – 10,000 m^3/day)	- About 3 – 4 WSS taken over annually	12,000	- Decree No. 117 executed by PPC	
5	- Gathering administration of provincial rural WSS	- 20 WSS added; over 60 WSS with its volume of 50,000 m^3/day each managed by Binh Thuan P-CERWASS up to 2001	1,500,000	- PPC guideline - Local agreement	- Estimated after 2011

ANNEX 5 TRAINING SEMINAR PROGRAME ON O&M AND REPAIRING OF PIPED-SCHEME WSS

Phu Yen P-Cerwass-239 National road 1- Ward 8-Tuy Hoa city-Phu Yen province

Tel: 057-823195; 057-212108

TRAINING SEMINAR PROGRAME ON O&M AND REPAIRING OF PIPED-SCHEME WSS

Time: 3 days, from July 03, 2008 to July 05, 2008 at Ai Cuc Hotel

Time	Programme	Detailed content	Tools	Presented by
First day. July 03, 2008				
7.00-7.30	Preparation	Registing of attendants		P-cerwass
7.30-8.00	Opening			P-cerwass
8.00-9.30	Presentation on	Electricity system, equipment and the operation of electric equipment in WSS	Projector+ Ao paper+ the brush (pen brush)	Leader of P-cerwass
9.30-9.45	**Coffee Break**			
9.45-10.30	Presentation	Electricity system, equipments and the operation of electric equipment in WSS	Projector+ Ao paper+ the brush (pen brush)	Mr. Trung Electric engineer
10.30-11.30	Presentation	Pump and pump's equipments	Projector+ Ao paper+ the brush (pen brush)	Mr. Trung Electrici engineer
11.30	**Break**	**For lunch**		
1.00-1.45	Presentation	Water treatment technology and equipments	Projector+ Ao paper+ the brush (pen brush)	Mr.Thai dat Water supply Engineer
1.45-3.15	Presentation	Technological process and works of the system such as: filtration tank, sedimentation tank..	Projector+ Ao paper+ the brush (pen brush)	Mr.Thai dat Water supply Engineer
3.15-3.30	**Coffee break**			
3.30-5.00	Presentation	O&M works, small repair and ways to deal with normal problems	Projector+ Ao paper+ the brush (pen brush)	Mr.Lieu Technical department
5.00	**Break**	**Finish first day**		
Second day. July 04, 2008				
7.00-9.15	Presentation	a. Introduction about water meters b. Process of recording water meter number c. Collecting and expending works of water charge d. Recording and transporting debt as financial law	Projector+ Ao paper+ the brush (pen brush)	Mr.Thanh Economic BA Sales department

Time	Programme	Detailed content	Tools	Presented by
9.15-9.30	**Coffee break**			
9.30-11.00	Presentation	Introduction of Documents and Regulations on operation and management of WSS in Phu Yen province	Projector+ Ao paper+ the brush (pen brush)	Mr.Thuan-Vice Director of water supply engineering Co
11.00	**Break**	**For lunch**		
1.00-1.45	Presentation	Introduce popular materials	Projector+ Ao paper+ the brush (pen brush)	Mr.Thang-Vice Director of water supply engineering Co
1-45-3.15	Presentation	Installation and construction part	Projector+ Ao paper+ the brush (pen brush)	Mr.Thang-Vice Director of water supply engineering Co
3.15-3.30	**Coffee break**			
3.30-5.00	Presentation	Repairing and overcoming problems	Projector+ Ao paper+ the brush (pen brush)	Mr.Thang-Vice Director of water supply engineering Co
5.00	**Break**	**Finish day 2**		
Third day. July 05, 2008				
Morning	Practicing of	Theories learned on first day	Tool and equipments	All attendants
Afternoon	Practicing of	Theories learned on second day **Ending the training course**	Tools and equipments	All attendants

ANNEX 6 CURRICULUM/SYLLABUS

CURRICULUM/SYLLABUS
(Course: Water Loss Prevention)

I-OBJECTIVE OF THE COURSE:

* Enhancing the ability of the water supply companies staff in evaluating the water loss level of the system.
* Analyzing the causes, determining the program and countermeasures, and organizing and implementing the water loss prevention work effectively.
* Enhancing the skills of using and maintaining the leakage investigation equipment, managing the water meters, maintaining the pipelines, and overcoming the incidents in the pipelines.

II-TRAINING OBJECTS:

* The staff of the water supply companies in charge of water loss prevention.
* The technicians and managers in charge of maintaining and operating the water supply system.
* The staff in charge of meter management and inspection.

II-DURATION:

* The course's duration is 6 days (the total is 60 periods) including the opening ceremony, closing ceremony and final discussion and evaluation.

IV- DETAILED CURRICULUM/SYLLABUS:

NO.	CONTENTS	NUMBER OF PERIODS (1 period = 45 mins.)		
		Theory	*Practice*	*Total*
1.	**WATER LEAKEGE CONTROL** **1.1. Generalization** 1.1.1. Real situation of water leakage and water loss 1.1.2 Forms of water loss 1.1.3. The dispensability of water loss prevention 1.1.4. Benefit, cost, and economic effect 1.1.5. Distributed water amount analysis **1.2. Causes of leakage** **1.3. Water loss prevention measures** 1.3.1. Planning for leakage investigation 1.3.2. Leakage amount measurement 1.3.3. Zoning for determining the leaked water amount 1.3.4. Methods for leakage detection 1.3.5. Leakage investigation equipment a. Leak noise listening bar b. Correlator c. Pipe, valve box lid, and meter locator d. Equipment for measuring the flow, pressure, and checking the water quality e. Equipment maintenance	**10**	**10**	**20**
	1.4 Leakage prevention work management 1.4.1. Organization of the leakage prevention system 1.4.2. Management of the planning work 1.4.2. Management of leakage prevention work **1.5 Practice of using the leakage investigation equipment**			

NO.	CONTENTS	NUMBER OF PERIODS (1 period = 45 mins.)		
		Theory	***Practice***	***Total***
2	**PIPELINE LAYING TECHNIQUE** **2.1. Basic theory on pipeline** 2.1.1. Generalization 2.1.2. Function of the pipeline 2.1.3. Basic effects on the pipeline durability 2.1.4. Impact of the pipeline laying work on the pipeline lifetime **2.2 Pipeline laying technique** 2.2.1. Introduction 2.2.2. Water supply pipe laying technique a. Cast-iron pipe laying b. PVC pipe laying c. Steel pipe laying d. Service pipe laying e. Installation of the pipe accessories 2.2.3. Pipeline laying quality check and pressure test **2.3. Practice of pipeline laying** 2.3.1. Technical requirement 2.3.2. Measuring tools for pipeline laying check 2.3.3. Kinds of joints and manipulation in installation 2.3.4. Methods of pipe turning, cutting, and grinding, and manipulation 2.3.5. Practice a. Practice of cutting, and threading the galvanized pipes b. Practice of pipe and accessories installation c. Practice of service pipe laying d. Practice of pressure test on the water supply pipe e. Practice of drilling and branching on the pressured pipeline	**5**	**10**	**15**
3	**PIPELINE MAINTENANCE TECHNIQUE** **3.1 Activities of the maintenance section** 3.1.1. Concept of pipeline maintenance 3.1.2. Function of pipeline maintenance 3.1.3. Methods of pipeline replacement and maintenance 3.2. Causes of corrosion and countermeasures 3.2.1. Phenomenon of metal corrosion 3.2.2. Corrosion inside and outside the pipeline 3.2.3. Pipeline corrosion countermeasures **3.3. Incident prevention and protection measures** 3.3.1. Impact of the pipeline incidents 3.3.2. Incident prevention measures 3.3.3. Measures for overcoming the incidents			
4	**METER MANAGEMENT AND INSPECTION** **4.1. Kinds and operation of the water meter** 4.1.1. Introduction 4.1.2. Meter structure and classification 4.1.3. Meter operation **4.2. Water meter maintenance** 4.2.1. Meter selection and installation 4.2.2. Mater maintenance 4.2.3. Meter inspection period 4.2.4. Meter management work 4.2.5. Meter telereading **4.3. Practice of water meter inspection** 4.3.1. Introduction 4.3.2. Error calculation 4.3.3. Inspection method and operation of the inspection equipment 4.3.4. Practice of inspection			

NO.	CONTENTS	NUMBER OF PERIODS (1 period = 45 mins.)		
		Theory	***Practice***	***Total***
5	**DISCUSSION AND FINAL TEST**		**5**	**5**
6	**OPENING CEREMONY, CLOSING CEREMONY, AND CERTIFICATION AWARDING**			**5**
TOTAL		***25***	***30***	***60***

ANNEX 7 FINANCIAL ANALYSIS

(1) Financial Analysis (IRR & NPV) : FPS-2

#	Year	Total Cost (US$)			[D] Net Income (US$)	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	2,000,500	0	2,000,500	0	-2,000,500	-2,000,500
2	2012	0	18,901	18,901	34,295	15,395	15,019
3	2013	0	19,064	19,064	34,591	15,528	14,779
4	2014	0	19,267	19,267	34,961	15,693	14,573
5	2015	0	19,471	19,471	35,330	15,859	14,368
6	2016	0	19,675	19,675	35,700	16,025	14,164
7	2017	0	19,878	19,878	36,069	16,191	13,962
8	2018	0	20,041	20,041	36,365	16,324	13,733
9	2019	0	20,286	20,286	36,808	16,523	13,561
10	2020	0	20,448	20,448	37,104	16,656	13,337
11	2021	0	20,734	20,734	37,621	16,888	13,193
12	2022	0	20,897	20,897	37,917	17,021	12,972
13	2023	0	21,100	21,100	38,287	17,186	12,779
14	2024	0	21,304	21,304	38,656	17,352	12,588
15	2025	0	21,508	21,508	39,026	17,518	12,398
16	2026	0	21,752	21,752	39,469	17,717	12,233
17	2027	0	21,956	21,956	39,839	17,883	12,047
18	2028	0	22,159	22,159	40,208	18,049	11,862
19	2029	0	22,404	22,404	40,652	18,248	11,700
20	2030	0	22,567	22,567	40,948	18,381	11,498
21	2031	0	22,852	22,852	41,465	18,613	11,359
22	2032	0	23,055	23,055	41,834	18,779	11,181
23	2033	0	23,300	23,300	42,278	18,978	11,024
24	2034	0	23,544	23,544	42,721	19,177	10,868
25	2035	0	23,748	23,748	43,091	19,343	10,694
26	2036	0	23,992	23,992	43,534	19,542	10,541
27	2037	0	24,277	24,277	44,052	19,774	10,406
		2,000,500	**558,178**	**2,558,678**	**1,012,823**	**-1,545,855**	**-1,673,663**
						FIRR=	**-8.6%**

(2) Financial Analysis (IRR & NPV) : FPS-3

#	Year	Total Cost (US$)			[D] Net Income (US$)	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	1,274,600	0	1,274,600	0	-1,274,600	-1,274,600
2	2012	0	12,967	12,967	67,852	54,884	53,546
3	2013	0	13,094	13,094	68,517	55,423	52,752
4	2014	0	13,236	13,236	69,256	56,020	52,021
5	2015	0	13,377	13,377	69,995	56,618	51,293
6	2016	0	13,518	13,518	70,734	57,216	50,571
7	2017	0	13,659	13,659	71,473	57,814	49,853
8	2018	0	13,815	13,815	72,286	58,472	49,190
9	2019	0	13,956	13,956	73,026	59,070	48,481
10	2020	0	14,097	14,097	73,765	59,667	47,777
11	2021	0	14,267	14,267	74,652	60,385	47,173
12	2022	0	14,408	14,408	75,391	60,983	46,478
13	2023	0	14,563	14,563	76,204	61,640	45,833
14	2024	0	14,719	14,719	77,017	62,298	45,192
15	2025	0	14,874	14,874	77,830	62,956	44,555
16	2026	0	15,030	15,030	78,643	63,613	43,923
17	2027	0	15,199	15,199	79,530	64,331	43,335
18	2028	0	15,369	15,369	80,417	65,048	42,749
19	2029	0	15,524	15,524	81,230	65,706	42,128
20	2030	0	15,679	15,679	82,043	66,364	41,512
21	2031	0	15,849	15,849	82,930	67,081	40,938
22	2032	0	16,004	16,004	83,743	67,739	40,331
23	2033	0	16,202	16,202	84,778	68,576	39,833
24	2034	0	16,371	16,371	85,665	69,293	39,268
25	2035	0	16,541	16,541	86,552	70,011	38,707
26	2036	0	16,725	16,725	87,512	70,788	38,182
27	2037	0	16,908	16,908	88,473	71,565	37,660
		1,274,600	**385,951**	**1,660,551**	**2,019,511**	**358,960**	**-101,318**
						FIRR=	**1.8%**

(3) Financial Analysis (IRR & NPV) : FPG-4

#	Year	Total Cost (US$)			[D] Net Income (US$)	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	4,484,600	0	4,484,600	0	-4,484,600	-4,484,600
2	2012	0	51,054	51,054	58,908	7,854	7,663
3	2013	0	51,630	51,630	59,573	7,943	7,560
4	2014	0	52,271	52,271	60,313	8,042	7,467
5	2015	0	52,847	52,847	60,978	8,130	7,366
6	2016	0	53,360	53,360	61,569	8,209	7,256
7	2017	0	54,193	54,193	62,530	8,337	7,189
8	2018	0	54,705	54,705	63,121	8,416	7,080
9	2019	0	55,346	55,346	63,860	8,515	6,988
10	2020	0	55,986	55,986	64,600	8,613	6,897
11	2021	0	56,691	56,691	65,413	8,722	6,813
12	2022	0	57,396	57,396	66,226	8,830	6,730
13	2023	0	57,972	57,972	66,891	8,919	6,632
14	2024	0	58,677	58,677	67,704	9,027	6,549
15	2025	0	59,317	59,317	68,443	9,126	6,459
16	2026	0	60,150	60,150	69,404	9,254	6,389
17	2027	0	60,791	60,791	70,143	9,352	6,300
18	2028	0	61,495	61,495	70,956	9,461	6,218
19	2029	0	62,200	62,200	71,769	9,569	6,135
20	2030	0	62,969	62,969	72,656	9,687	6,060
21	2031	0	63,673	63,673	73,469	9,796	5,978
22	2032	0	64,442	64,442	74,356	9,914	5,903
23	2033	0	65,146	65,146	75,169	10,023	5,822
24	2034	0	65,979	65,979	76,130	10,151	5,752
25	2035	0	66,620	66,620	76,869	10,249	5,667
26	2036	0	67,645	67,645	78,052	10,407	5,613
27	2037	0	68,477	68,477	79,012	10,535	5,544
		4,484,600	**1,541,031**	**6,025,631**	**1,778,113**	**-4,247,518**	**-4,314,570**
						FIRR=	**-15.0%**

(4) Financial Analysis (IRR & NPV) : FPS-5

#	Year	Total Cost (US$)			[D] Net Income (US$)	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	976,700	0	976,700	0	-976,700	-976,700
2	2012	0	11,765	11,765	44,865	33,100	32,293
3	2013	0	11,861	11,861	45,234	33,373	31,765
4	2014	0	11,997	11,997	45,752	33,755	31,345
5	2015	0	12,075	12,075	46,047	33,973	30,778
6	2016	0	12,191	12,191	46,491	34,300	30,316
7	2017	0	12,268	12,268	46,787	34,518	29,765
8	2018	0	12,385	12,385	47,230	34,845	29,314
9	2019	0	12,520	12,520	47,747	35,227	28,912
10	2020	0	12,617	12,617	48,117	35,500	28,426
11	2021	0	12,714	12,714	48,487	35,772	27,945
12	2022	0	12,811	12,811	48,856	36,045	27,472
13	2023	0	12,947	12,947	49,374	36,427	27,085
14	2024	0	13,044	13,044	49,743	36,699	26,622
15	2025	0	13,160	13,160	50,187	37,027	26,205
16	2026	0	13,257	13,257	50,556	37,299	25,754
17	2027	0	13,393	13,393	51,074	37,681	25,383
18	2028	0	13,509	13,509	51,517	38,008	24,979
19	2029	0	13,606	13,606	51,887	38,281	24,544
20	2030	0	13,722	13,722	52,330	38,608	24,150
21	2031	0	13,838	13,838	52,774	38,935	23,761
22	2032	0	13,974	13,974	53,291	39,317	23,409
23	2033	0	14,090	14,090	53,734	39,644	23,028
24	2034	0	14,187	14,187	54,104	39,917	22,621
25	2035	0	14,342	14,342	54,695	40,353	22,310
26	2036	0	14,459	14,459	55,139	40,680	21,942
27	2037	0	14,575	14,575	55,582	41,007	21,579
		976,700	**341,308**	**1,318,008**	**1,301,599**	**-16,409**	**-284,997**
						FIRR=	**-0.1%**

(5) Financial Analysis (IRR & NPV) : FKS-6

#	Year	Total Cost (US$)			[D] Net Income (US$)	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	1,151,400	0	1,151,400	0	-1,151,400	-1,151,400
2	2012	0	14,416	14,416	21,624	7,208	7,032
3	2013	0	14,694	14,694	22,042	7,347	6,993
4	2014	0	14,973	14,973	22,460	7,487	6,952
5	2015	0	15,286	15,286	22,930	7,643	6,924
6	2016	0	15,565	15,565	23,347	7,782	6,879
7	2017	0	15,948	15,948	23,922	7,974	6,876
8	2018	0	16,227	16,227	24,340	8,113	6,825
9	2019	0	16,575	16,575	24,862	8,287	6,802
10	2020	0	16,888	16,888	25,332	8,444	6,761
11	2021	0	17,271	17,271	25,907	8,636	6,746
12	2022	0	17,619	17,619	26,429	8,810	6,714
13	2023	0	17,968	17,968	26,951	8,984	6,680
14	2024	0	18,351	18,351	27,526	9,175	6,656
15	2025	0	18,769	18,769	28,153	9,384	6,641
16	2026	0	19,152	19,152	28,727	9,576	6,612
17	2027	0	19,535	19,535	29,302	9,767	6,579
18	2028	0	19,952	19,952	29,929	9,976	6,556
19	2029	0	20,370	20,370	30,555	10,185	6,530
20	2030	0	20,823	20,823	31,234	10,411	6,513
21	2031	0	21,276	21,276	31,913	10,638	6,492
22	2032	0	21,693	21,693	32,540	10,847	6,458
23	2033	0	22,181	22,181	33,271	11,090	6,442
24	2034	0	22,634	22,634	33,950	11,317	6,413
25	2035	0	23,156	23,156	34,734	11,578	6,401
26	2036	0	23,643	23,643	35,465	11,822	6,377
27	2037	0	24,201	24,201	36,301	12,100	6,368
		1,151,400	**489,165**	**1,640,565**	**733,748**	**-906,817**	**-978,176**
						FIRR=	**-8.7%**

(6) Financial Analysis (IRR & NPV) : FKS-8

#	Year	Total Cost (US$)			[D] Net Income (US$)	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	1,989,600	0	1,989,600	0	-1,989,600	-1,989,600
2	2012	0	21,352	21,352	24,601	3,249	3,170
3	2013	0	21,624	21,624	24,914	3,291	3,132
4	2014	0	21,896	21,896	25,228	3,332	3,094
5	2015	0	22,259	22,259	25,646	3,387	3,069
6	2016	0	22,531	22,531	25,959	3,429	3,030
7	2017	0	22,848	22,848	26,325	3,477	2,998
8	2018	0	23,165	23,165	26,690	3,525	2,966
9	2019	0	23,528	23,528	27,108	3,580	2,939
10	2020	0	23,845	23,845	27,474	3,629	2,906
11	2021	0	24,162	24,162	27,839	3,677	2,872
12	2022	0	24,525	24,525	28,257	3,732	2,844
13	2023	0	24,888	24,888	28,675	3,787	2,816
14	2024	0	25,250	25,250	29,093	3,842	2,787
15	2025	0	25,522	25,522	29,406	3,884	2,749
16	2026	0	25,885	25,885	29,824	3,939	2,720
17	2027	0	26,248	26,248	30,242	3,994	2,691
18	2028	0	26,656	26,656	30,712	4,056	2,666
19	2029	0	27,018	27,018	31,130	4,112	2,636
20	2030	0	27,381	27,381	31,548	4,167	2,606
21	2031	0	27,744	27,744	31,966	4,222	2,576
22	2032	0	28,152	28,152	32,436	4,284	2,551
23	2033	0	28,514	28,514	32,854	4,339	2,520
24	2034	0	28,968	28,968	33,376	4,408	2,498
25	2035	0	29,376	29,376	33,846	4,470	2,471
26	2036	0	29,784	29,784	34,316	4,532	2,445
27	2037	0	30,192	30,192	34,786	4,594	2,418
		1,989,600	**663,312**	**2,652,912**	**764,251**	**-1,888,661**	**-1,917,430**
						FIRR=	**-15.1%**

(7) Financial Analysis (IRR & NPV) : FNG-10

#	Year	Total Cost (US$)			[D] Net Income (US$) / After Tax	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	10,734,100	0	10,734,100	0	-10,734,100	-10,734,100
2	2012	0	119,042	119,042	136,987	17,946	17,508
3	2013	0	121,526	121,526	139,846	18,320	17,438
4	2014	0	124,075	124,075	142,780	18,705	17,369
5	2015	0	126,755	126,755	145,864	19,109	17,312
6	2016	0	129,305	129,305	148,798	19,493	17,229
7	2017	0	132,050	132,050	151,958	19,907	17,166
8	2018	0	134,731	134,731	155,042	20,311	17,087
9	2019	0	137,476	137,476	158,201	20,725	17,010
10	2020	0	140,483	140,483	161,662	21,178	16,958
11	2021	0	143,360	143,360	164,972	21,612	16,883
12	2022	0	146,432	146,432	168,507	22,075	16,824
13	2023	0	149,505	149,505	172,043	22,538	16,759
14	2024	0	152,512	152,512	175,503	22,992	16,679
15	2025	0	155,976	155,976	179,490	23,514	16,642
16	2026	0	159,114	159,114	183,101	23,987	16,562
17	2027	0	162,514	162,514	187,013	24,500	16,503
18	2028	0	165,913	165,913	190,925	25,012	16,438
19	2029	0	169,378	169,378	194,912	25,534	16,372
20	2030	0	172,842	172,842	198,899	26,057	16,299
21	2031	0	176,568	176,568	203,187	26,618	16,244
22	2032	0	180,229	180,229	207,399	27,170	16,177
23	2033	0	184,152	184,152	211,913	27,762	16,126
24	2034	0	188,008	188,008	216,351	28,343	16,062
25	2035	0	191,996	191,996	220,940	28,944	16,002
26	2036	0	196,049	196,049	225,604	29,555	15,942
27	2037	0	200,168	200,168	230,344	30,176	15,880
		10,734,100	**4,060,158**	**14,794,258**	**4,672,243**	**-10,122,016**	**-10,300,629**
						FIRR=	**-14.5%**

(8) Financial Analysis (IRR & NPV) : FBS-11

#	Year	Total Cost (US$)			[D] Net Income (US$) / After Tax	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	1,964,900	0	1,964,900	0	-1,964,900	-1,964,900
2	2012	0	19,880	19,880	23,492	3,612	3,524
3	2013	0	20,203	20,203	23,874	3,671	3,494
4	2014	0	20,526	20,526	24,256	3,730	3,463
5	2015	0	20,849	20,849	24,638	3,788	3,432
6	2016	0	21,132	21,132	24,972	3,840	3,394
7	2017	0	21,455	21,455	25,354	3,899	3,362
8	2018	0	21,819	21,819	25,784	3,965	3,335
9	2019	0	22,142	22,142	26,166	4,023	3,302
10	2020	0	22,506	22,506	26,595	4,089	3,275
11	2021	0	22,748	22,748	26,882	4,134	3,229
12	2022	0	23,112	23,112	27,312	4,200	3,201
13	2023	0	23,476	23,476	27,741	4,266	3,172
14	2024	0	23,839	23,839	28,171	4,332	3,142
15	2025	0	24,203	24,203	28,601	4,398	3,112
16	2026	0	24,607	24,607	29,078	4,471	3,087
17	2027	0	24,971	24,971	29,508	4,537	3,056
18	2028	0	25,334	25,334	29,938	4,603	3,025
19	2029	0	25,738	25,738	30,415	4,677	2,999
20	2030	0	26,142	26,142	30,893	4,750	2,971
21	2031	0	26,546	26,546	31,370	4,824	2,944
22	2032	0	26,950	26,950	31,848	4,897	2,916
23	2033	0	27,355	27,355	32,325	4,971	2,887
24	2034	0	27,759	27,759	32,803	5,044	2,858
25	2035	0	28,163	28,163	33,280	5,117	2,829
26	2036	0	28,607	28,607	33,805	5,198	2,804
27	2037	0	29,011	29,011	34,283	5,272	2,774
		1,964,900	**629,073**	**2,593,973**	**743,380**	**-1,850,593**	**-1,883,311**
						FIRR=	**-14.5%**

(9) Financial Analysis (IRR & NPV) : FBG-13

#	Year	Total Cost (US$)			[D] Net Income (US$) / After Tax	[E] Benefit - Cost (US$) =[D] - [C]	[F] Net Present Value (US$) =[E] / (1+OCC)$^{t-1}$
		[A] Investment Cost	[B] O & M Cost	[C] Total =[A] + [B]			
1	2011	12,759,700	0	12,759,700	0	-12,759,700	-12,759,700
2	2012	0	150,225	150,225	159,381	9,156	8,933
3	2013	0	152,340	152,340	161,625	9,285	8,838
4	2014	0	154,410	154,410	163,822	9,411	8,739
5	2015	0	156,526	156,526	166,066	9,540	8,643
6	2016	0	158,776	158,776	168,453	9,677	8,553
7	2017	0	160,936	160,936	170,745	9,809	8,458
8	2018	0	163,276	163,276	173,228	9,952	8,372
9	2019	0	165,392	165,392	175,472	10,080	8,273
10	2020	0	167,867	167,867	178,098	10,231	8,192
11	2021	0	170,297	170,297	180,676	10,379	8,108
12	2022	0	172,547	172,547	183,064	10,517	8,015
13	2023	0	175,023	175,023	185,690	10,667	7,932
14	2024	0	177,498	177,498	188,316	10,818	7,848
15	2025	0	179,973	179,973	190,942	10,969	7,763
16	2026	0	182,493	182,493	193,616	11,123	7,680
17	2027	0	185,059	185,059	196,338	11,279	7,598
18	2028	0	187,759	187,759	199,202	11,444	7,521
19	2029	0	190,414	190,414	202,020	11,606	7,441
20	2030	0	192,979	192,979	204,741	11,762	7,357
21	2031	0	195,725	195,725	207,654	11,929	7,280
22	2032	0	198,515	198,515	210,614	12,099	7,204
23	2033	0	201,395	201,395	213,670	12,275	7,130
24	2034	0	204,230	204,230	216,678	12,448	7,054
25	2035	0	207,156	207,156	219,782	12,626	6,981
26	2036	0	210,081	210,081	222,885	12,804	6,906
27	2037	0	213,051	213,051	226,037	12,985	6,833
		12,759,700	**4,673,942**	**17,433,642**	**4,958,814**	**-12,474,828**	**-12,556,047**
						FIRR=	**-18.3%**