2.2 Socio-Economic Condition

The survey aims at clarifying present socio-economic conditions and demands of local people regarding water supply as well as sanitary condition at the MP's targeted study area. The number of interviews in total amounts to about 10% of all the households, 3,875 households.

The followings brief the result of socio-economic survey and Table 2.2.1 summarizes it.

- The population of Study area is approximately 180 thousand as of 2006 with an average growth rate of 1.6%.
- Average rate of minority is 10%. Majority of population in the Study area belongs to ethnic Kin. In addition to ethnic Kin, there are some other "minority" ethnic groups such as Cham, Raclay, Hroi, Ede, Bana, and others.
- Average poverty rate is 17.8%. Poverty still remains as the most primary issue to tackle in the Study area, but the extent of poverty is unequal among communes.
- Average monthly expenditure per household is VND2,754,000. The income of major fraction of population relies mainly on farming products such as rice, sugarcane, cassava, vegetable and/or fishing (incl. aquaculture) with some retail side business.
- Despite the presently improving condition, many people still have concern on frequent occurrence of water related diseases including diarrhea, skin diseases such as trachoma, and some other diseases
- Significant needs on water supply exist in many communes in general. However, the degree of its significance on their needs varies from communes to communes.
- Selling price of water ranges from 20,000 VND to 30,000 VND/m^3, depending on location and season.

Table 2.2.1 Result of Socio-Economic Survey

Item	Unit	Phu Yen	Khanh Hoa	Ninh Thuan	Binh Thuan	Total or Average	
Population	Person	49,402	18,174	53,025	59,257	179,858	(total)
Population grouth rate	%/year	1.2	1.7	2.4	1.4	1.6	(average)
Minority groups	%	12.0	0.0	23.0	3.0	10.0	(average)
Poverty ratio	%	21.3	14.3	26.0	13.7	17.8	(average)
Monthly Expenditure*1	000VND	1,996	2,437	2,159	3,439	2,754	(average)
Waterborne disease	-	1. Diarrhea: 18% 2. Malaria: 13% 3. Skin disease: 13%	1. Skin disease: 11% 2. Diarrhea: 6% 3. Schistso-me: 6%	1. Diarrhea: 20% 2. Trachoma: 18% 3. Malaria: 12%	1. Diarrhea: 19% 2. Skin disease: 17% 3. Schistso-me: 16%	1. Diarrhea: 12% 2. Skin disease: 10% 3. Trachoma: 9%	(average)
Local people's needs on water supply*2	%	36.3	54.2	65.3	44.4	48.5	(average)

*1: Monthly expenditure per household
*2: Rate of people who need much more water than water volume available at present

2.3 Water Supply

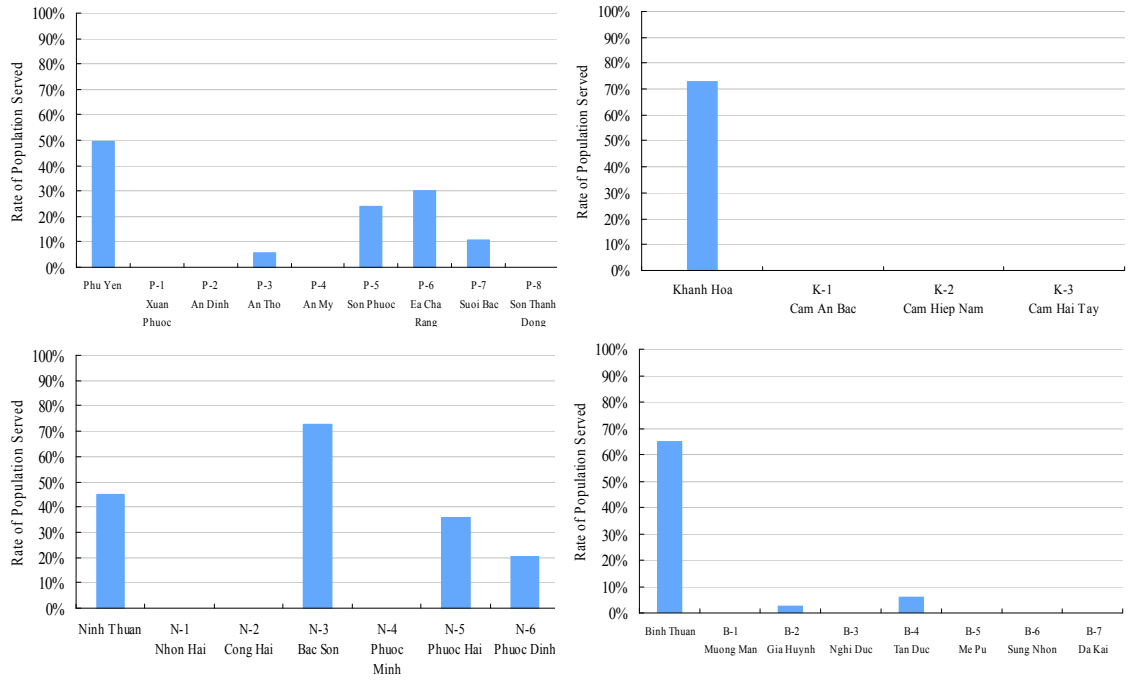
2.3.1 Current Status of Rural Water Supply

Rate of access to safe water in rural area is 66% (N-CERWASS, 2006), up more than 20 percent

from the year 2000 when National Rural Water Supply and Sanitation Strategy (NRWSSS) was formulated. It is prospected that the target rates by the year 2010 as well as 2020 could be reached on condition that current progress would be maintained. Since difficult areas for groundwater development remains to be worked on due to severe natural conditions, and communes of poverty and ethnic minority are also left from getting benefits of development, more efficient development than ever before is required.

Ratio of rural population in Vietnam served by piped water supply system is approximately 30%. The Vietnamese government puts higher priority on the piped scheme for its advantageous nature in terms of water quality control. However, there have been few cases that got into troubles because maintenance was not properly performed even though it is a piped system.

The ratio of population served in each commune in 2006 is shown in Figure 2.3.1. Most of the target communes are lower than the provincial average in 2006. Towards achieving the target of the NRWSS, it is necessary to improve the condition of sufficient water in the target communes.



Note: Commune with code K-1 is under procedure of approval for implementation of waterworks, and water supply system in N-4 is under construction Thus, rate of population served is 0%.
Source: CPC data

Figure 2.3.1 Ratio of Population Served in the Target Communes in 2006

2.3.2 Condition of Water Use

(1) Water source

As to the availability of water, different pictures by places are observed, particularly in rainy season and dry season as shown in Table 2.3.1. Primary water sources for people in the Study area are piped water, dug well, tube well, spring, river/stream, rain water and purchased water. More than 70% people rely on dug well.

The usage rate of primary water sources doesn't vary with the seasons. In dry season, people have difficulty in finding alternative water source due to water shortage. Therefore, people have no choice but use same water source and live by reducing water consumption as a temporary measures. Thus, the capacity of current water sources is unstable.

People rely on purchase water in some areas. The water price sold by water vendor is high and is being a burden to their domestic account. Rate of households purchasing water is approx. 10% of total. Because actual situation is explained from the interviews with local people, that is, water vendors are not common business in most communes and people have no chance to access water vendors. And water price is very expensive. Therefore, people reduce water consumption and keep minimum expenses.

The water supply with low water charge, stable water supply and safe water quality by piped water scheme mitigates resident burden and contributes improvement of living standard.

Table 2.3.1 Primary Water Source in Rainy Season and Dry Season

Province	No. of Sumples	Season	Piped water	Dug well	Tube well	Spring	River/ Stream	Rain water	Purchase water	Other	TOTAL
Phu Yen	1153	Rainy	3.1%	67.3%	23.0%	2.1%	0.2%	0.8%	0.0%	3.6%	100.0%
		Dry	3.1%	65.0%	24.0%	3.4%	0.3%	0.0%	0.1%	4.1%	100.0%
Khanh Hoa	480	Rainy	0.0%	81.9%	0.6%	0.0%	0.0%	4.0%	12.1%	1.5%	100.0%
		Dry	0.0%	71.0%	0.8%	0.2%	0.0%	0.2%	25.2%	2.5%	100.0%
Ninh Thuan	996	Rainy	6.5%	52.9%	1.3%	4.2%	0.0%	11.1%	17.0%	6.9%	100.0%
		Dry	7.2%	51.5%	1.3%	5.6%	0.0%	0.2%	26.2%	7.9%	100.0%
Binh Thuan	1,246	Rainy	0.2%	79.1%	7.4%	0.0%	0.4%	8.9%	0.5%	3.5%	100.0%
		Dry	0.2%	83.9%	7.6%	0.5%	0.7%	0.6%	1.4%	5.1%	100.0%
Total	3,875	Rainy	2.7%	69.2%	9.6%	1.7%	0.2%	6.5%	6.0%	4.2%	100.0%
		Dry	2.8%	68.4%	10.0%	2.6%	0.3%	0.3%	10.3%	5.2%	100.0%

Source: Socio-economic survey by the JICA study team

(2) Water demand

The per capita consumption in the Study area is shown in Table 2.3.2. As indicated in Table, per capita consumption in the Study area is 120 l/ day. Specifically for drinking, cooking and shower purposes only, the consumption is generally observed to be around 20 to 30 l/person/day.

Table 2.3.2 Per capita Consumption in the Study Area

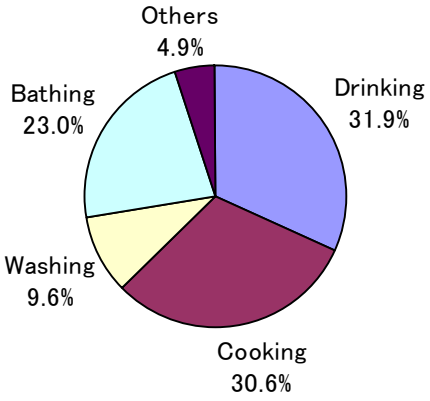
Province	Average of per capita consumption (l/person/day,)
Phu Yen	82.3
Khanh Hoa	122.0
Ninh Thuan	78.1
Binh Thuan	187.6
Average	120.0

Source: Socio-economic survey by the JICA study team

Water use allocation for additional clean water based on socio-economic survey

With the formulation and improvement of water supply system, additional amount of clean water will be available for use. From the viewpoint of water use allocation for additional clean water by

purposes, the users priority goes to drinking, followed by cooking and bathing purposes.



Source: Socio-economic survey by the JICA study team

Figure 2.3.2 Preference of Users for Additional Available Water (average of four (4) provinces)

Pattern of water use in Communes

The water use for the retail business in the rural area is classified as non-domestic water. The rate of non-domestic water is generally small and the average rate of non-domestic water is approx. 12% in case when the rate of domestic water is 100%.

2.3.3 Water Quality

Problems of water quality in the study area are shown in the Table 2.3.3. According to table, the necessity of piped water scheme is very high to address the following issues regarding water quality.

- Contaminated water due to high turbidity in rainy season and turbidity is indicated in dug wells in all communes.
- High salinity and this has compelled users to purchase water in spite of water availability in dug wells.
- Presence of fluoride in water in dug well, which, people believe, is one of the reason to cause dental fluorosis.
- Presence of calcium in water, which, people believe, is one of the reasons to cause kidney stone.

Table 2.3.3 Problems of Water Quality in the Study Area

Province	Code	Commune	Problems of water quality						
			Turbidity*1	Fluoride	Salinity	Ca	High pH	Metallic Taste	Odor
Phu Yen	P-1	Xuan Phuoc	X	X		X		X	
	P-2	An Dinh	X	X				X	
	P-3	An Tho	X	X	X		X	X	
	P-4	An My	X	X	X				
	P-5	Son Phuoc	X						X
	P-6	Ea Cha Rang	X	X		X	X		
	P-7	Suoi Bac	X			X			
	P-8	Son Thanh Dong	X						
Khanh Hoa	K-1	Cam An Bac	X	X	X				
	K-2	Cam Hiep Nam	X	X					
	K-3	Cam Hai Tay	X	X	X				
Ninh Thuan	N-1	Nhon Hai	X		X				
	N-2	Cong Hai	X	X	X			X	
	N-3	Bac Son	X		X				
	N-4	Phuoc Minh	X		X				
	N-5	Phuoc Hai	X		X			X	
	N-6	Phuoc Dinh	X		X				
Binh Thuan	B-1	Muong Man	X	X	X	X		X	
	B-2	Gia Huynh	X	X				X	
	B-3	Nghi Duc	X	X					
	B-4	Tan Duc	X	X		X		X	
	B-5	Me Pu	X	X				X	
	B-6	Sung Nhon	X	X				X	
	B-7	Da Kai	X	X				X	

*1: Turbidity is indicated in rainy season.

2.3.4 Issues of Existing Drinking Water Source

Based on the result of socio-economic survey and survey for existing wells, some issues of existing water source is identified in the targeted 24 communes. Main issues of existing water source and water use is shown in the Table 2.3.4. The detaled result is shown in Main report and Supporting report.

Table 2.3.4 Main Issues of Exisitng Drinking Water Source

Province	Code	Commune	Volume*1	Quality*2	Fetching*3
Phu Yen	P-1	Xuan Phuoc	X	X	
	P-2	An Dinh		X	
	P-3	An Tho	X	X	
	P-4	An My		X	X
	P-5	Son Phuoc	X	X	
	P-6	Ea Cha Rang	X	X	X
	P-7	Suoi Bac	X	X	
	P-8	Son Thanh Dong		X	
Khanh Hoa	K-1	Cam An Bac	X	X	
	K-2	Cam Hiep Nam	X	X	X
	K-3	Cam Hai Tay	X	X	
Ninh Thuan	N-1	Nhon Hai	X	X	
	N-2	Cong Hai	X	X	
	N-3	Bac Son	X	X	

Province	Code	Commune	Volume*1	Quality*2	Fetching*3
	N-4	Phuoc Minh	X	X	X
	N-5	Phuoc Hai	X	X	
	N-6	Phuoc Dinh	X	X	
Binh Thuan	B-1	Muong Man	X	X	
	B-2	Gia Huynh	X	X	
	B-3	Nghi Duc	X	X	
	B-4	Tan Duc	X	X	
	B-5	Me Pu		X	
	B-6	Sung Nhon		X	
	B-7	Da Kai	X	X	

*1: More than 30% of respondents need much more water than water volume available in primary water source, and more than 30% of respondents need additional water volume for drinking purpose.
*2: More than 50% of respondents feel unsatisfied with water quality in primary water source and/or problems of water quality is pointed out by the result of survey for existing wells
*3: More than 30% of respondents spend about more than 10-30 minutes for fetching water.

2.3.5 Existing Piped Water Supply System

There are eleven (11) existing piped water supply systems in eleven (11) communes out of twenty four (24) communes. The ratio of population served in these communes to their total population is 29%. Table 2.3.5 shows Outline of existing water supply system.

Table 2.3.5 Outline of Existing Water Supply System

Province	Commune	Code	Organization for operation	Served population	Total population in commune	Ratio of served PP
Phu Yen	An Tho	P-3	Private	184	3,312	6%
	Son Phuoc	P-5	CPC	777	3,313	23%
	Ea Cha Rang	P-6	CPC	772	2,616	30%
	Suoi Bac	P-7	Urban Water Supply	600	5,678	11%
Khanh Hoa	Com An Bac	K-1	CPC (Under procedure of approval)	1,305	6,440	20%
Ninh Thuan	Bac Son	N-3	DPC/CPC	4,226	5,922	71%
	Phuoc Minh	N-4	Urban Water Supply (Plan)	3,509	3,509	100%
	Phuoc Hai	N-5	CPC	4,581	13,126	35%
	Phuoc Dinh	N-6	CPC	1,717	8,912	19%
Binh Thuan	Gia Huynh	B-2	Private	117	5,305	2%
	Tan Duc	B-4	Urban Water Supply	314	5,052	6%
Total				18,102	63,185	29%

Source: Field survey for water supply system by JICA study team

In general, the private water supply system is small scale and the rate of population served in these cases is low with less than 6%. Many facilities such as intake and distribution reservoir are demolished or partially destroyed because of aging or defective maintenance.

The drinking water quality of some community water supply systems managed by CPC and DPC is unsatisfactory due to defects in treatment system. Turbidity is high compared to drinking water

standards. In some of the water sources of dug well, there is water shortage in dry season for duration of 4 to 5 months. The distribution pipeline is roughly in favorable conditions. Rehabilitation or reconstruction of some intake facilities for water source is required. In Cam An Bac commune, construction of water supply facilities has been completed and this system is under procedure of approval for implementation of waterworks.

Urban water supply system supplies water to two communes. In this case, the water volume and quality is controlled under urban water supply company. However, it is expected that the diameter of distribution pipeline will not meet water flow requirements in future. In Phuoc Minh commune (N-4), there is water supply plan funded by ADB, will complete construction at the year 2011. Evaluation of the existing water supply system is presented in Table 2.3.6

Table 2.3.6 Evaluation of Existing System

Province	Commune	Code	Available water sources	Supply capacity (l/c/d)	Treatment Process	Facility				Evaluation
						Intake	Treatment plant	Distribution Reservoir	Distribution pipe	
Phu Yen	An Tho	P-3	Good	33-50	Insufficiency	Deterioration	Aging	Deterioration	Aging	x
	Son Phuoc	P-5	Good	33-50	Sufficiency	Good	N/A	Good	Good	O
	Ea Cha Rang	P-6	Good	30-45	Sufficiency	Good	N/A	N/A	Good	O
	Suoi Bac	P-7	From urban water supply	20-30	Sufficiency	N/A	N/A	N/A	Good	O
Khanh Hoa	Com An Bac	K-1	Good	30-50 (Under procedure of approval)	Sufficiency	Good	Good	Good	Good	O
Ninh Thuan	Bac Son	N-3	Good	50-60	Sufficiency	Good	N/A	N/A	Good	O
	Phuoc Minh	N-4	From urban water supply	(Plan)	Sufficiency	N/A	N/A	N/A	Good	O
	Phuoc Hai	N-5	Good	40-50	Insufficiency	Aging	N/A	Deterioration	Defect	x
	Phuoc Dinh	N-6	Dry up in dry season	40-50	insufficiency	Defect	Good	Good	Good	x
Binh Thuan	Gia Huynh	B-2	Dry up in dry season	40-50	Insufficiency	Deterioration	N/A	Deterioration	Defect	x
	Tan Duc	B-4	From urban water supply	50-60	Sufficiency	N/A	N/A	N/A	Good	O

2.4 Sanitation

2.4.1 Current Situation on Sanitary Toilets in Rural Communes of Vietnam

(1) Rate of Access to Sanitary Toilets

According to the living standard survey (General Statistics Office, 2004), 83.43% of rural households are reported to have toilet. However, only about half of them are regarded as sanitary toilets, since toilet located directly over the water and other type of toilets should be excluded from improved sanitation. As a result, the rate of access to improved sanitation in rural area is assumed to be 41.8%.

Severer situation is reported in the "Rural Environmental Sanitation Survey in Vietnam (MOH, 2007)". The report describes overall picture of access to water supply and sanitation as well as personal hygiene of rural people through the extensive questionnaire survey of 37,306 households in 20 provinces. According to the survey, it was reported that only 22.5% of rural households have sanitary toilets constructed in accordance with the hygiene standards for various types of latrines (No. 08/2005/QD-BYT). Also, only 18% of rural households have toilets that meet the standards on construction, proper use and maintenance. It seems that the survey results by MOH (2007) reveal actual status of rural communes in Vietnam rather than the national living standard survey (2004). It is pointed out that main reason of the difference in figures between two surveys is that the hygiene standards were not promulgated before 2005.

(2) Government's Approach to Rural Sanitation

Since the national target of rural sanitation is prospected to be difficult to reach and personal hygiene of rural people is insufficient, priority subjects are to review the target ratio of access to sanitary toilet and to enhance IEC activities on sanitation.

In order to promote sanitary improvement further, the central government takes efforts towards better cooperation among agencies concerned. Also, the promotion of IEC on sanitation and increase of preferential loans to rural people are under discussion.

2.4.2 Socio-Economic Survey Result

(1) Pervasion of Toilet installation

Slightly more than half of the households have one of the kinds of toilet within their own yard. The ratio of households that have toilet provision, however, varies from communes to communes, depending on whether they received projects to promote installation of toilets or not, and on their own awareness of sanitation.

Table 2.4.1 Rate of Households to have installed Toilets

			Installed				Installed				Installed
Phu Yen	P-1	Xuan Phuoc	17%	Khanh Hoa	K-1	Cam An Bac	40%	Binh Thuan	B-1	Muong Man	54%
	P-2	An Dinh	31%		K-2	Cam Hiep Nam	64%		B-2	Gia Huynh	34%
	P-3	An Tho	9%		K-3	Cam Hai Tay	71%		B-3	Nghi Duc	28%
	P-4	An My	39%		**Total**		**62%**		B-4	Tan Duc	41%
	P-5	Son Phuoc	4%	Ninh Thuan	N-1	Nhon Hai	56%		B-5	Me Pu	50%
	P-6	Ea Cha Rang	5%		N-2	Cong Hai	7%		B-6	Sung Nhon	45%
	P-7	Suoi Bac	45%		N-3	Bac Son	5%		B-7	Da Kai	52%
	P-8	Son Thanh Dong	13%		N-4	Phuoc Minh	52%		**Total**		**44%**
	Total		**25%**		N-5	Phuoc Hai	58%	**TOTAL**		**40%**	
					N-6	Phuoc Dinh	53%				
					Total		**42%**				

Source: Socio-economic survey by the JICA study team

(2) Local Needs on Sanitary Condition

The Socio-economic survey confirmed that approx. 80% (in total of "Strongly need" and "If possible, need") of respondents need installation of toilets, particularly in communes where the pervasion rate of toilets is smaller. The degree of the demands basically accords with the current pervasion rate, but is also affected by local people's awareness of importance of toilet.

As to the types of the toilets, the most popular type is both Septic tank toilet and pour flush type toilet. Some of the lessons from the past governmental/international promotional activities on toilets are: DVCL type toilet has not been accepted so much as expected because it is more troublesome in handling, it has smell, and there is less incentives to use residue/human excremental matter as fertilizer.

2.4.3 Type of Sanitary Latrines

Four types (1: Double Vault Compositin Latrine, 2: VIP (Ventilated Improved Pit Latrine, 3: Pour Flush Latrine, 4: Pour Flush with Septic Tank Latrine)) of latrines are promulgated as the hygienic standards for latrine (08/2005/QD-BYT, MOH). Two more types are now being studied by MOH; including biogas toilet and toilet for flood area. On completion of the study, they are to be added to the standard.

According to the survey on rural water and sanitation (MOH, 2007), approximately 75% of total interviewees do not know well about the four types of toilets.

2.4.4 Knowledge, Attitude and Practice on Sanitation

A nationwide KAP (Knowlede, Attitude and Practice) survey was carried out by MOH in 2007 (Vietnam Rural Environmental Sanitation, MOH). The survey discovered that knowledge and behavior of rural people is very limited level, although some progress is found since last a few years.

Significant correlation factors are analyzed, such as education level, sex, ethnic group, income level and topographic condition. Clear tendency is found out that people having better access to information and education show better knowledge and practice, although they are still low level.

In Vietnam, diarrhea accounts for 18% of total disease and death in hospital. And it is estimated about 14,000 children die for diarrhea every year. In contrast, only 2.3% respondents know the fact that washing hand by soap is one way to prevent diarrhea and parasitic worm diseases and 12% respondents have behavior of hand-washing by soap after meal and toilet.

Regarding domestic water source, 11.6% of respondents have bad manner of drinking raw water, despite the fact that only 25.1% of domestic water samples met the water quality standard in coliform parameter (survey by MOH, in 2006).

2.5 Institutional Framework and Management

2.5.1 Institutional Framework

(1) Transition of RWSS in Vietnam

GOV has taken efforts toward RWSS improvement since year 1982 when WATSAN program supported by UNICEF was launched. It has been developed to NTP for RWSS. These programs have been supported by bilateral and international donor assistances in extensive forms of technical cooperation, loans and grants for construction, capacity building, institutional reform, etc.

The recent transitions in RWSS sector are derived from NRWSSS up to year 2020 and its action programs of NTPs for RWSS. The RWSS NTP II for 2006 – 2010 was launched in December 2006 to succeed and enhance the achievements of NTP I during 1999 – 2005.

(2) National Rural Water Supply and Sanitation Strategy (NRWSSS)

In August 2000, the GOV introduced the "National Rural Water Supply and Sanitation Strategy (NRWSSS) up to the year 2020" with support from DANIDA. It indicates a national goal on RWSS that aims to provide all rural people with clean water and sanitation facility. NRWSSS's basic underlying principles; sustainable development, demand responsive approach and socialization of RWSS, provides guidance to the whole sector as well as to all RWSS programs and projects. The objectives and strategies of NRWSSS are summarized below:

Table 2.5.1 Objectives of NRWSSS

Objectives	
Development Objectives	- Improved Health of the Rural Population - Improved Living Conditions - Reduced Environmental Pollution from Human and Livestock Excreta
Immediate Objectives By Year 2020	- All rural people will use clean water with 60 L/c/d and use hygienic latrines - Universal good personal hygiene practice of rural people, good environmental sanitation of communes and villages
Immediate Objectives By Year 2010	- 85% of rural population will use clean water with 60 L/c/d - 70% of rural households will have hygienic latrines and have good personal hygienic practices

Source: NRWSSS up to 2020, August 2000

(3) NTP for RWSS

As the action plan of NRWSSS, GOV has implemented National Target Program for RWSS to follow principles of NRWSSS. Reviews of the first target program for RWSS NTP I (2000-2005) concluded that the approach and objectives of the national strategy are relevant but the principles are inconsistently implemented in practice. The RWSS NTP II (2006-2010) has been launched since December 2006 to succeed and enhance the achievements of NTP I.

In principle, most activities and investments for RWSS are to take place through the framework of RWSS NTP II (2006-2010). The outline of RWSS NTP II is summarized in the Project Design Matrix (PDM) as shown in Table 2. The objectives of NTP II by 2010 include 85% of rural population have access to hygienic water, and 70% of rural households have hygienic latrines. The total budget is estimated to be VND 22,600,000 million.

Significant changes introduced by NTP II mainly focus on demand-driven approaches, introducing market mechanism and socialization, increased attention to IEC and capacity building. Changes in institutional arrangements include transfer of the standing office for NTP and state management responsibility from N-CERWASS to MARD. This is attributed to the fact that closer coordination among related agencies is more important and coordination in central government is aimed by rising up the implementation agency to the ministry level.

Table 2.5.2 Project Design Matrix of RWSS NTP II

Project Summary	Index	Monitoring Method	External Condition
Super goal			
- Living conditions of rural people improved by improving rural water supply and sanitation services and raising community awareness of environment protection - Negative impacts on rural people's health due to poor water supply and sanitation conditions reduced and environment pollution in the community minimized.	- Number of water supply and sanitation facilities constructed - Number of people provided with IEC on RWSS - Percentage of water borne diseases reduced	- Quarterly and annual report - Survey data - Survey report	- Improvement in living conditions of rural people - Improvement in health of rural people - Improvement of environment of rural community
Project Objective			
- 85% of rural population use clean water by 2010 - 70% of rural households have hygienic latrines by 2010 - 70% of rural households have hygienic livestock pens by 2010 - All schools and public institutes have access to clean water and hygienic latrines by 2010	- Percentage of rural population using clean water - Percentage of rural population having hygienic latrines - Percentage of rural population having hygienic livestock pens - Number of schools and public institutes having clean water and hygienic latrines	- Quarterly and annual reports, survey data - Annual reports, survey data - Annual reports, survey data - Summary reports, evaluation reports	- O&M for RWSS are continued and regularly monitored
Achievement			
- Provision of 159,200 water supply systems - Provision of 2,601,000 household	- Number of rural people having access to clean water - Number of households	- Quarterly and annual reports - Quarterly and annual	- Operation and maintenance for RWSS facilities are continuously carried out - O&M costs for RWSS

hygienic latrines - Provision of 5,000,000 livestock pens and biogas systems - Provision of hygienic latrines for public institutions	having hygienic latrines - Number of households having livestock pens and biogas systems - Number of public institutions having access to clean water supply and hygiene latrines	reports - Quarterly and annual reports - Quarterly and annual reports	facilities are covered by users
Activities - Building and upgrading of 159,200 water supply systems - Building of 2,601,000 household hygienic latrines - Building and renovation of 5,000,000 livestock pens and biogas systems - Building hygienic latrines for public institutions	Input - Project financing of 22,600 billion VND 1) State government budget: 3,200 billion VND 2) Local government budget: 2,300 billion VND 3) International support: 3,400 billion VND 4) People's contribution: 8,100 billion VND 5) Preferential loans: 5,600 billion VND - Project management organizations to implement RWSS improvement		- Budget disbursement based on demand-driven approach - Project management and coordination - IEC and hygienic promotion Precondition - Sustainable water source are identified - Proper technology for RWSS improvement are applied - Land, water rights, other permissions are obtained

Source: NTP II Logical framework, modified and added by JICA Study Team

(4) Poverty Reduction Supporting National Program (Program 134, 135)

The GOV promulgated National Decrees No. 134/2004/QD-TTg and 135/1998/QT-TTg, also called Program 134 and 135, respectively, in order to improve living standards and support socio economic development of poor people, ethnic minorities and residents in remote areas. The programs provide agricultural lands and houses through the government budget. It also supports construction of housing facilities including water supply and sanitation facilities. The investments are provided directly by Committee for Ethnic Minorities (CEMA) besides NTP II.

(5) VBSP's Preferential Loan to RWSS

VBSP (Vietnam Bank for Social Policy) is a government-affiliated financial institution established under the decision No. 131/2002/QD-TTg by the Prime Minister on the basis of reorganization from Vietnam Bank for the Poor, in order to support poor households and small business households in remote areas.

Under the Decision No. 62/2004/QD-TTg by the Prime Minister on credits for Clean Water and Rural Sanitation National Target Program, VBSP provides credits to rural households to construct RWSS facilities with the upper limit of VND 4 million at a preferential interest rate of 0.65% per month.

According to VBSP report (October 2007), several issues are pointed out; e.g. (i) lower amount of credit compared to demands of customers, (ii) many defects found in design specifications and building techniques, and (iii) few involvement of MARD/N-CERWASS in the business transaction which causes insufficient dissemination and technical guidance to rural people.

(6) Laws and Regulations

There is no law for water supply and sanitation in Vietnam which stipulates requirements of WSS and duties of waterworks, etc. Instead of laws, several standards and roles of related organizations are stated by Decisions by the GOV. Sector standards are to be applied for RWSS by Decisions 08/2005/QD-BYT and 09/2005/QD-BYT for hygienic latrines and clean water, respectively. Other water quality standards also exist, such as national drinking water quality standard (Decision 1329/2002/QD-BYT and National Standard; TCVN 5505-2003) and domestic wastewater standards (TCVN6772, 2000), and it is pointed out that they should be integrated. Related laws and standards are listed in table below.

Table 2.5.3 Related Laws and Standards in RWSS

Title	Code
Law on the Water Resources	20/5/1998
Law on Environmental Protection	17/12/2003
Drinking Water Quality, MOH	Decision 1329/2002/QD-BYT, 18/4/2002
National standard	TCVN5505, 2003
Sector Standards: Hygiene Standards for Various Types of Latrines, MOH	Decision 08/2005/QD-BYT, 11/3/2005
Sector Standards: Hygiene Standards for Clean Water, MOH	Decision 09/2005/QD-BYT, 11/3/2005
Water quality standards; Surface Water	TCVN5942, 1995
Water quality standards; Coastal Water	TCVN5943, 1995
Water quality standards; Groundwater	TCVN5944, 1995
Domestic wastewater standards	TCVN6772, 2000

2.5.2 Organization

(1) Administrative Organization

There are two administrative ministries in relation to water supply and sanitation; MARD for rural areas and MOC for urban areas. MARD delegates responsibility for RWSS implementation to N-CERWASS (Decision 122/2003/QD-BNN). N-CERWASS is a public administration agency with income belonging to MARD, specializing in RWSS nationwide.

Other ministries are also involved and play key roles in RWSS, coordinating with MARD. MOH regulates water quality standards as well as standard for hygienic latrine and plays important role in IEC. MOET is in charge of school sanitation, education and construction of water supply and sanitation facilities in schools. In addition, MONRE is in charge of water resources management including groundwater development, wastewater treatment and solid waste management.

Under the government policy of decentralization, local governments administrate in accordance with guidance by the central government. Local governments, at all levels of provincial, district, commune and village, have significant roles to play in every phase of planning, financing, implementation and O&M of services and facilities. Administration in provincial level is governed by PPC which has similar structure and roles corresponding to the central ministries. In principle, RWSS in provincial level is implemented by P-CERWASS under DARD. DPC and CPC are administration authorities at district and commune level respectively, who can manage and coordinate any public activities at local level. In some provinces, DPC and CPC are engaged in O&M of public

water supply system.

(2) Implementing Organization (P-CERWASS)

P-CERWASS is an implementing authority of RWSS at provincial level, which belongs to DARD of the province. Annual budget of P-CERWASS is proposed by P-CERWASS, submitted through DARD to PPC and approved by PPC. Directors of P-CERWASS are appointed by PPC. In some cases, director level personnel are sent from DARD, while personnel changes seldom occur between N-CERWASS and P-CERWASS. N-CERWASS provides technical guidance and training courses to P-CERWASS. In projects funded by international donor, N-CERWASS is responsible for project coordination between international donors and Vietnamese authorities.

Organizational profiles of P-CERWASS in the Study areas are presented in Supporting report.

2.5.3 International Cooperation

(1) Vietnam Rural Water Supply and Sanitation Partnership

In response to “Hanoi Core Statement on Aid Effectiveness” signed in 2005, the Memorandum of Understanding (MOU) was signed in May 2006 between MARD and interested donors, including World Bank, ADB, UNICEF, Australia, Denmark and Netherlands.

The partnership sets a framework in accordance with the policy of NRWSSS and aims to maximize effectiveness and to harmonize assistance schemes to RWSS sector by means of establishing information sharing and coordinating structure among partners.

(2) Joint Donor Support to RWSS NTP II

AusAid, DANIDA and Netherlands are cooperating with the GOV in RWSS through provision of targeted budget support program (TBSP) for NTP II. The supporting fund is transferred to the GOV, then it is to be allocated through budget executing channel of Vietnam, as the budget for NTP II.

As of November 2007, standing offices are established in MARD and DARD (or P-CERWASS) of the nine pilot provinces. Accordingly international advisors are assigned to assist preparation of TOR for technical assistance.

(3) UNICEF

RWSS in Vietnam was practically initiated in 1982 when WATSAN program started with assistance by UNICEF. Approximately 170 thousands of rural water supply facilities have been constructed and provided under the program from the year 1982 to 1996, that contributed largely to improved rate of access to water supply in rural areas. Approximately, 80% of total investment on rural water supply during 1992 to 1997, which amounts to approximately US$ 54 million, was contributed in the form of the WATSAN program. Thus, WATSAN is the core program on RWSS.

UNICEF started WES (Water, Environment and Sanitation) program in year 2001 to improve RWSS and environmental protection. Under the WES program for 2006 to 2010, “RWSS and environment project” and “Environmental sanitation project” are carried out. The project budget is

approximately US$10 million and most of them are used for training, IEC and capacity development. WES principle is to focus on children and poor/ethnic minorities.

(4) World Bank

The World Bank is supporting the RWSS sector through the Red River Delta Water Supply and Sanitation Project (2005-2009). The project components include construction of RWSS facilities of 12 provinces, IEC on sanitation, capacity development on institutional strengthening and assistance to project management.

(5) ADB

The ADB provides support for rural water and sanitation indirectly through broad based rural infrastructure projects. The ADB is committed to the principles of the NTPII in the preparation of future RWSS interventions.

2.5.4 Decision Making and Water Charge Collection System

(1) Decision Making System

RWSS project is basically initiated by CPC and requested to DPI through DPC. DPI consults with P-CERWASS to evaluate project and forwards/proposes/report to PPC. In planning phase, P-CERWASS is involved to prioritize target commune to implement by rating from criteria; water demand, water scarcity, population density, and poverty reduction.

In every phase, final decision is made by PPC. In most cases, state and provincial budget is allocated to RWSS implementation, so that project ownership is mostly held by PPC. It is some cases that CPC would contribute its land or a part of project cost. PPC assigns P-CERWASS to design and construct the facilities. P-CERWASS, in charge of project implementation, employs state owned enterprises or private firms for facility design and construction.

It is PPC that decides O&M entity; P-CERWASS, DPC, CPC, village, users group or others including private firms

(2) Tariff

Water tariff is proposed by water management entity and approved by PPC. In most provinces where P-CERWASS manages RWSS systems, uniform tariff is applied to the whole province. Tariff is set to cover operation and maintenance cost, not including capital cost. Remedial measures are considered for poor households.

(3) Metering and Bill Collection

For the piped scheme with house connection, water meter is equipped for individual households. Currently meter reading and bill collection is performed by meter readers, who read meters, distribute bill and collect water charge.

2.5.5 Financial Plan

(1) Central Government Budget

The budget for rural water supply service in Vietnam is basically allocated by the MARD and via the MOF to the PPC in each province in due course. It is then distributed to the DPC and the CPC. N-CERWASS and P-CERWASS formulate and request budget proposals but are not involved in financial flow relating to water supply projects.

Also, some PPCs and DPCs operate projects directly under the assistance of a donor organization or the central government, so that N-CERWASS or P-CERWASS does not know or monitor all rural water supply projects.

(2) Investment in Water Supply Projects by the Four Province

In general, budget for P-CERWASSs comes from the Central and/or Provincial government, except Khanh Hoa P-CERWASS which received 445 million VND from the UNICEF and other international agencies in 2005.

(3) Budget for P-CERWASS

Same as Investment in the water supply projects, each P-CERWASS has a different financial structure. For instance, budget for P-CERWASS in Khanh Hoa and Phu Yen are primarily composed of labor costs and their fund sources are mainly the central and provincial budgets, and donor agencies. On the other hand, P-CERWASS in Binh Thuan and Ninh Thuan are managed by the self-support accounting system since they directly operate and manage water supply facilities, which earn revenues mainly from water charges and appropriate them to a part of the operation budget.

2.6 Legal System concerning Environmental and Social Considerations

Outline of legal aspects related to environmental and social considerations, land system and water quality standards in Vietnam, which are important items for water supply project, are described below.

Environmental and Social Considerations

The environmental considerations required in case of implementation of Project in Vietnam consist of three items, which are Strategic Environmental Impact Assessment (SEA), Environmental Impact Assessment (EIA), and Environmental Protection Commitments (EPC).

Based on the regulation concerning the environmental and socio-economic consideration, priority projects in this study do not need SEA and EIA. However, it is essential that EPC is submitted to district people's committee before implementation of project.

Land System in Vietnam

From regulation concerning land system (Law on Land No.13/2003/QH11 and Decree No.197/2004/ND-CP), the following items are mentioned as salient features of the land system of the Vietnam government.

- Land is under the ownership of the entire citizen, and the State is the representative of the owner. Also, the State performs uniform management of land.
- The State shall recover the land when the State needs to use it for the purposes of national defense and security, national interests, public interests, or economic development.
- Persons who have land recovered shall be compensated with new land having the same use purposes. If there is no land for compensation, they shall receive compensation equal to the land use right value at the time of issuance of the recovery decisions.

Drinking and Domestic Water Quality Standards

In Vietnam, there are two water quality standards concerning water supply project, one is the drinking water hygienic standards (Promulgated together with the Decision of Minister of Health No 1329/2002/BYT/QD dated April 18, 2002), and another is the domestic supply water quality requirements (TCVN 5502-2003).

2.7 Groundwater Source

2.7.1 Hydrogeological Conditions of the Target Communes

(1) Results of Field Reconnaissance

The results of hydrogeological field survey are summarized as follows:

- Four communes (P-2: An Dinh, N-2: Cong Hai, N-3: Bac Son and B-4: Tan Duc) have perennial rivers in their communes; however, the river waters are used for irrigation, not for drinking water because of agricultural chemical pollution.
- One commune (B-3: Nghi Duc) has perennial spring in the commune;however, the quantity is small, and not enough for the users.
- Five communes (P-1:Xuan Phuoc, P-7:Suoi Bac, P-8: Son Thanh Dong, N-4: Phuoc Minh, B-6: Sung Nhon) have reservoirs or ponds for irrigation.
- Many surface waters in the communes dry up in the dry season.

The main water resource for drinking in the 24 target communes are dugwells during the dry season. Eight communes (P-2: An Dinh, P-8: Son Thanh Dong, K-1: Cam An Bac, N-1: Nhon Hai, N-3: Bac Son, N-4: Phuoc Minh, B-1: Muong Man and B-4: Tan Dac) buy drinking water in the dry season. Two communes (K-2: Cam Hiep Nam, K-3: Cam Hai Tay) use rainwater as drinking water in the rainy season.

(2) Inventory Survey of Existing Wells

Inventory survey of existing wells in the target 24 commune was conducted including interviewing to representatives of the communes about existing wells, and identifying the representative wells with

the highest water quality, richest water quantity and deepest depth in each target commune and so on. The main findings of the survey are as follows:

- Many of households in the target communes have dugwells in their garden. Many dugwells dry up in the dry season. They have custom to share groundwater of dugwells in water scarce season.
- The main groundwater quality problem in the target communes are salination and fluoride, especially all target communes in Ninh Thuan province have salination problem.
- The fluoride problem concentrates in Phu Yen and Khanh Hoa provinces.

An Tho and Ea Cha Rang communes have high pH problem. Groundwater with high pH may cause fluoride elution from rocks.

(3) Geophysical Survey

Geophysical survey was carried out by Vertical Electrical Sounding (VES) and Horizontal Electrical Profiling (HEP) for the following purposes:

- To figure out the geological and hydrogeological conditions in the target communes for groundwater exploitation
- To decide just one site for the test borehole drilling survey in each commune.

The VES points were selected four to six points in each commune based on topographic and geological conditions, accessibility or trafficability for the mobilization of a drilling machine and CPC's reference information.

(4) Test Borehole Drilling Survey

Test borehole drilling survey consists of drilling work, geophysical logging, well construction, pumping test and water quality analysis. This survey was carried out to obtain hydrogeological information, to monitor groundwater level and water quality, and to utilize for consideration of the groundwater potential evaluation. The test borehole drilling sites were decided by evaluation of five indices: namely, lineaments, catchment area, aquifer thickness, electric resistivity (permeability) and water quality (saline intrusion). The test borehole drilling survey was carried out in 24 communes as shown in Figure 2.7.1. The results of the test borehole drilling survey are summarized in Table 2.7.1 and described in the Supporting Report and Data Book in detail.

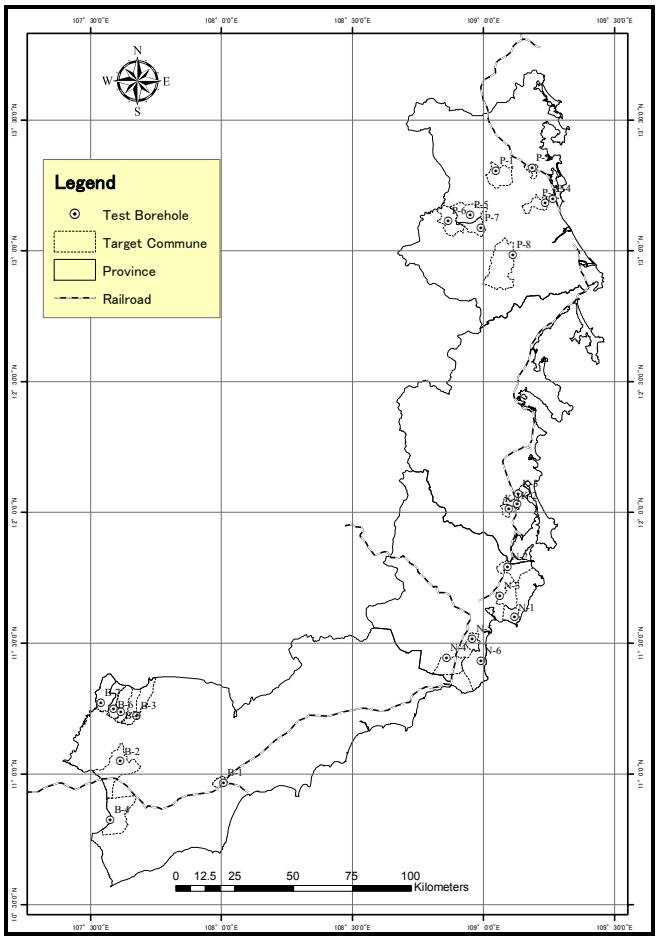


Figure 2.7.1 Location Map of Test Boreholes

2.7.2 Fluctuation of Groundwater Level

Groundwater level of the test boreholes had been monitored in order to evaluate potentiality of groundwater development for the rural water supply in 24 communes.

The monitoring was carried out daily in the rainy season and every 5 days in the dry season for more than half a year: March 2008 to September 2008. Groundwater fluctuation of each test borehole is shown in Figure 2.7.2 and Figure 2.7.3 and its characteristic is described as follows by province.

Table 2.7.1 Summary of Test Borehole Drilling Survey

Province	Test well No.	Commune	Thickness of Alluvium (m)	Type* of Bedrock	Aquifer Type	Pumping Test Results				**Water Quality							
						Static Water Level (GL m)	Draw-down (m)	Safe Yield (l/min)	Safe Yield (m^3/day)	F	Cl^-	Fe	Mn	$KMnO_4$	$CaCo_3$	TDS	Zn
Phu Yen	P-1	Xuan Phuoc	10.0	Gr	Fracture	-2.00	-22.63	4.0	6								
	P-2	An Dinh	3.5	Gr	Alluvium, Fracture	-3.00	-9.30	200.0	288	M	X					X	
	P-3	An Tho	-	Ba, SR	Fracture	-43.50	-6.08	80.0	115					X			
	P-4	An My	8.0	Ba, SR	Fracture	0.80	-14.06	480.0	691								
	P-5	Son Phuoc	1.0	Ba, Gr	Fracture	-6.00	-17.00	4.0	6	X							
	P-6	Ea Cha Rang	4.0	Gr	Fracture	-6.00	-33.81	15.0	22				M				
	P-7	Suoi Bac	2.5	Gr	Fracture	-7.00	-30.10	5.0	7	X							
	P-8	Son Thanh Dong	-	Ba, An	Joint, Fracture	-12.70	-0.91	300.0	432								
Khanh Hoa	K-1	Cam An Bac	11.0	Gr	Weathering, Fracture	-1.60	-9.76	250.0	360			M	M				
	K-2	Cam Hiep Nam	15.0	Gr	Weathering, Fracture	-6.70	-25.17	40.0	58			X					X
	K-3	Cam Hai Tay	10.0	Gr	Intrusive, Fracture	0.60	-15.00	200.0	288								
Ninh Thuan	N-1	Nhon Hai	5.0	Gr	Fracture	-7.00	-29.62	90.0	130		X		M		X	X	
	N-2	Cong Hai	8.7	An	Fracture	-3.50	-11.37	35.0	50								
	N-3	Bac Son	5.0	Gr	Weathering, Fracture	-2.50	-14.10	90.0	130		X	X	X		X	X	
	N-4	Phuoc Minh	2.0	Gr	Fracture	-4.00	-36.00	1.0	1	M	X			M		X	
	N-5	Phuoc Hai	8.0	Gr	Weathering	-1.30	-13.65	60.0	86		X		X	X	X	X	
	N-6	Phuoc Dinh	15.0	Gr	Weathering	-6.80	-13.67	35.0	50	X				X			
Binh Thuan	B-1	Muong Man	10.0	SR	Fracture	-5.30	-7.47	25.0	36								
	B-2	Gia Huynh	5.7	Gr	Fracture	-1.64	-26.41	30.0	43								
	B-3	Nghi Duc	8.0	Gr	Fracture	-1.10	-10.03	3.0	4								
	B-4	Tan Duc	10.0	Gr	Weathering, Fracture	-2.50	-5.87	12.0	17						X		
	B-5	Me Pu	8.0	Gr	Weathering	-1.90	-21.30	45.0	65								
	B-6	Sung Nhon	8.0	Gr	Fracture	-0.80	-19.00	45.0	65								
	B-7	Da Kai	3.0	Ba, Gr	Alteration, Fracture	-5.60	-52.90	4.8	7								

* Gr: Granite, Ba: Basalt, SR: Sedimentary Rock, An: Andesite
** X:Dissatisfy Drinking Water Standards, M: Marginal of Drinking Water Standards

- Phu Yen province

  Although fluctuation of groundwater level in the dry season is small except P-3, rising up of it from the beginning of the rain season in September is recognized. P-3 has deeper groundwater level and shows greater fluctuation than others do. The reason why P-3 shows the great water level rising of in the dry season is not clear. On the other hand, since P-8 has no seasonal fluctuation of water level, it may be under different hydrogeological conditions from others.

Table 2.7.2 Estimated Division of Season

Target Province	Rainy Season	Dry Season
Phu Yen	September to December (4 month)	January to August (8 month)
Khanh Hoa	September to December (4 month)	January to August (8 month)
Ninh Thuan	September to December (4 month)	January to August (8 month)
Binh Thuan	May to October (6 month)	November to April (6 month)

- Khanh Hoa province

  K-1 and K-3 have fracture type of aquifer and fluctuation of their water level is stable during the monitoring period. In contrast, K-2 has weathered granite aquifer and greater seasonal change than they do, and besides, have only one fifth of their withdrawal.

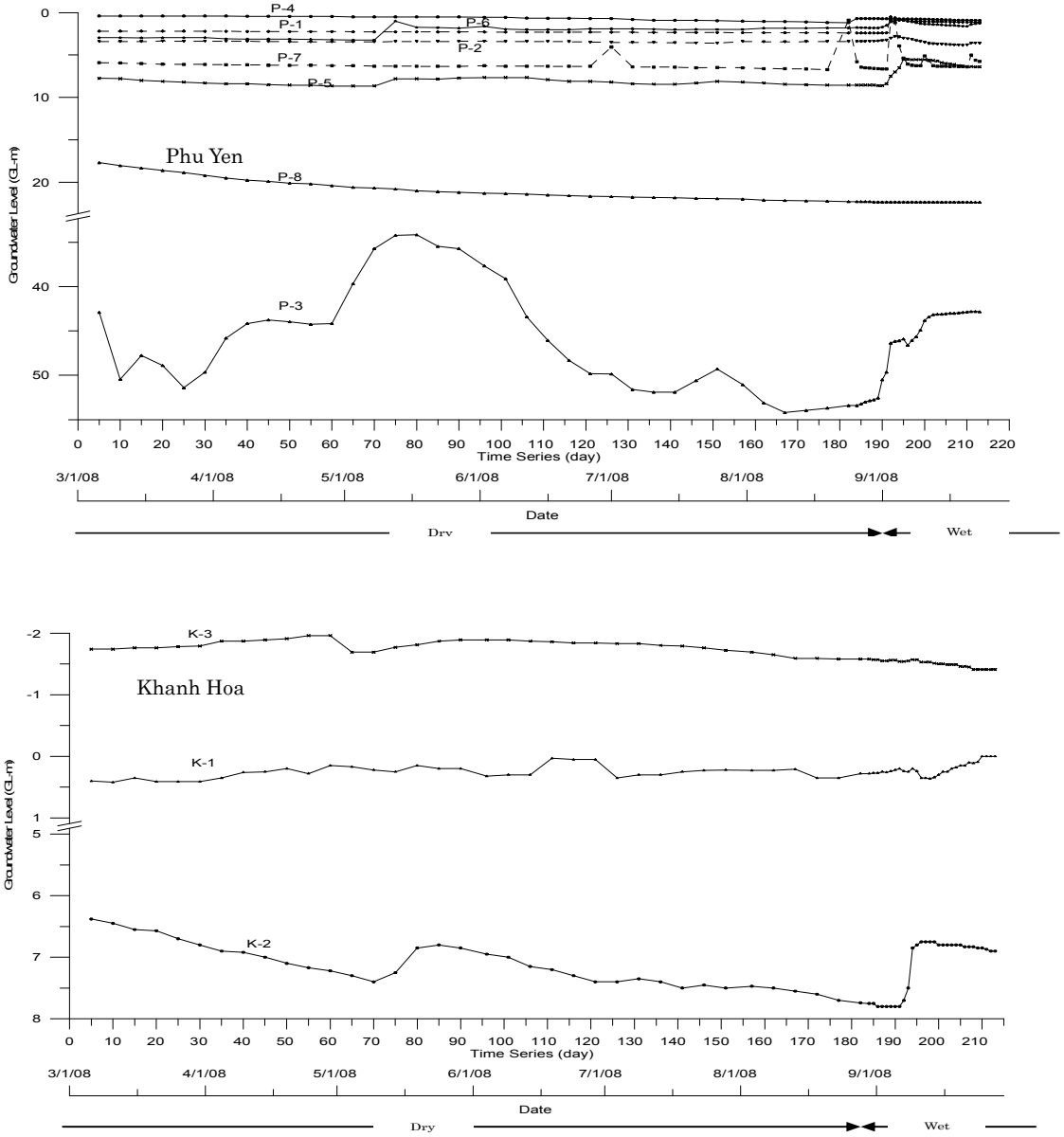


Figure 2.7.2 Fluctuation of Groundwater Level in Test Boreholes (1)

- Ninh Thuan province

  In general, water level fluctuation of all test boreholes in Ninh Thuan province is very small. Drawdown of N-1 in April seems to be withdrawn by water usage. N-1, 2 and 5 show water levels rising at the starting of the rainy season; however, N-3 and 4 has almost no reaction. For some reason, N-6 shows reverse of them after the rainy season.

- Binh Thuan province

  Since Binh Thuan province had much longer rainy season than other three provinces during the

monitoring period, a dynamic movement of water level was recorded. The annual range of fluctuation of groundwater level in this province is two meter to three.

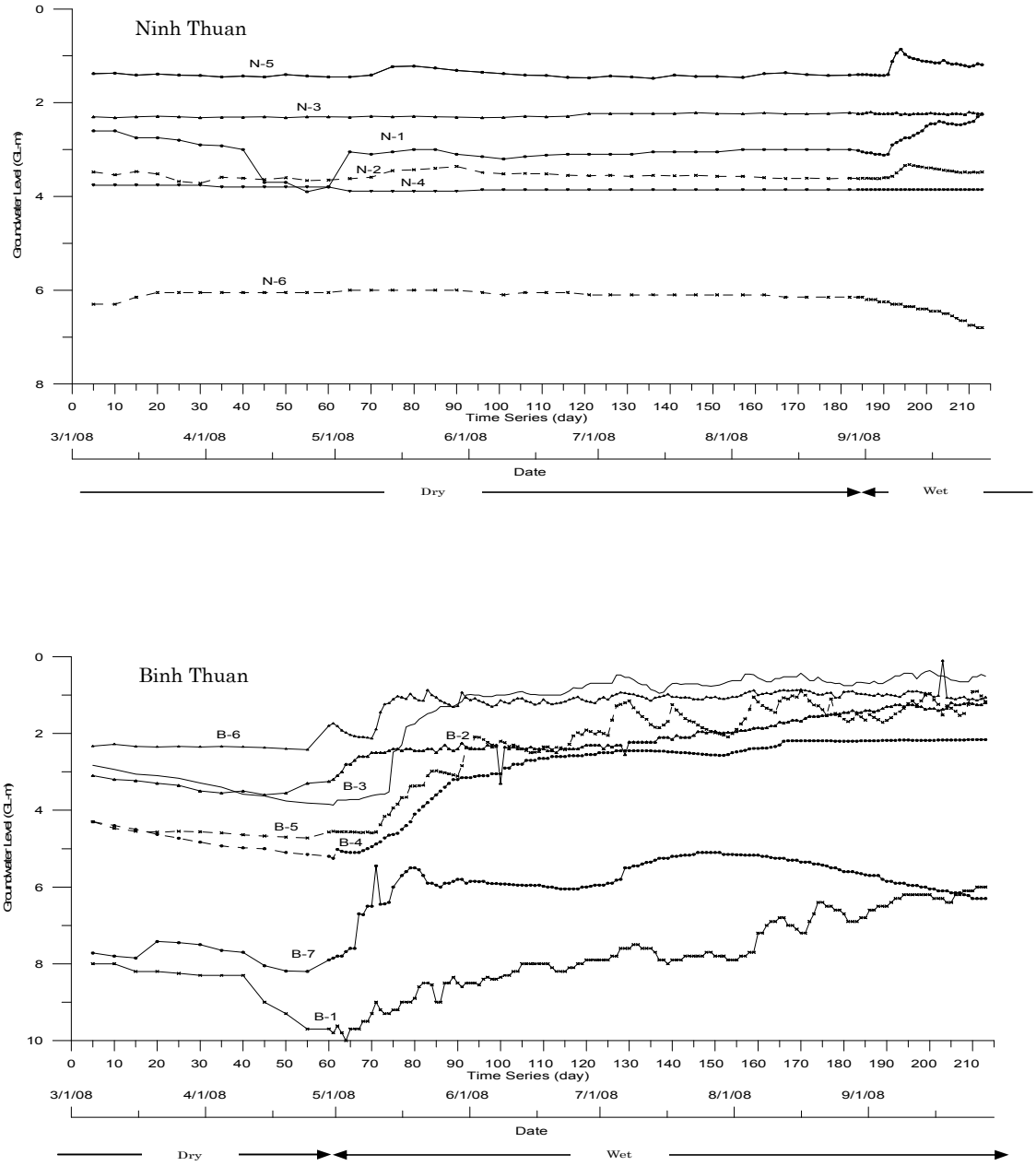


Figure 2.7.3 Fluctuation of Groundwater Level in Test Boreholes (2)

2.7.3 Impact of Seawater Intrusion

(1) Seawater Intrusion Survey along Coastal Zone of the Study Area

This survey was conducted in August and November 2007 to study the current state of salination of groundwater along coastal zone of the study area. Five hundred survey points were selected from coastal plains where their ground surface were lower than 20m A.S.L (above seawater level) as shown in Figure 2.7.4. Affection degree of seawater intrusion is presented in Figure 2.7.5 based on the following category for evaluation.

- Less than 250 mg/L: Satisfy TCVN 5942-1995 (Drinking Water Standard for whole Vietnam)
- 250 to 400 mg/L: Satisfy TCVN 5943-1995（Drinking Water Standard for Coastal area）
- Over 400 mg/L: Dissatisfy Drinking Water Standards

Regional characteristics on seawater intrusion base on the survey are described below.

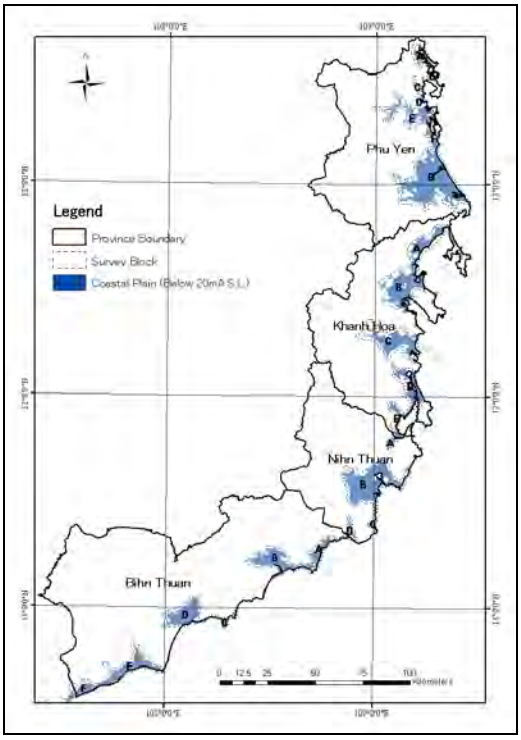


Figure 2.7.4 Selected Coastal Plains for Preparatory Suvey on Seawater Intrusion

- Phu Yen Province

  Affection of seawater intrusion is found within seven km from shoreline of Song Cau and Tuy district. P-4 (An My) belongs to this area. Although the affected wells are found locally in Da Rang river delta which extends to Phu Hoa and Tuy Hoa district, almost whole area of the delta contains non saline groundwater because of enough recharge from Da Rang River.

- Khanh Hoa

  Affection of seawater intrusion is found considerably in Tan Lam River basin and Cai river basin. Contaminated wells are found up to 18 to 27 km landward. Main reason for this is poor recharge condition caused by small scaled catchment. Coastal zone of Cam Ranh district is generally affected by seawater intrusion. K-3 (Cam Hai Tay) belongs to this zone.

- Ninh Thuan

  Almost whole coastal zone where is lower then 20 A.S.L.m is affected by seawater intrusion. Especially, such affected area extends up to approximately 22 km in Dinh River basin. All target communes; N-1 to 6 belong to this area. Main reason for this is poor recharge condition much severe than Khanh Hoa as shown in Figure 3.2.8 caused by little precipitation as shown Figure 2.1.2.

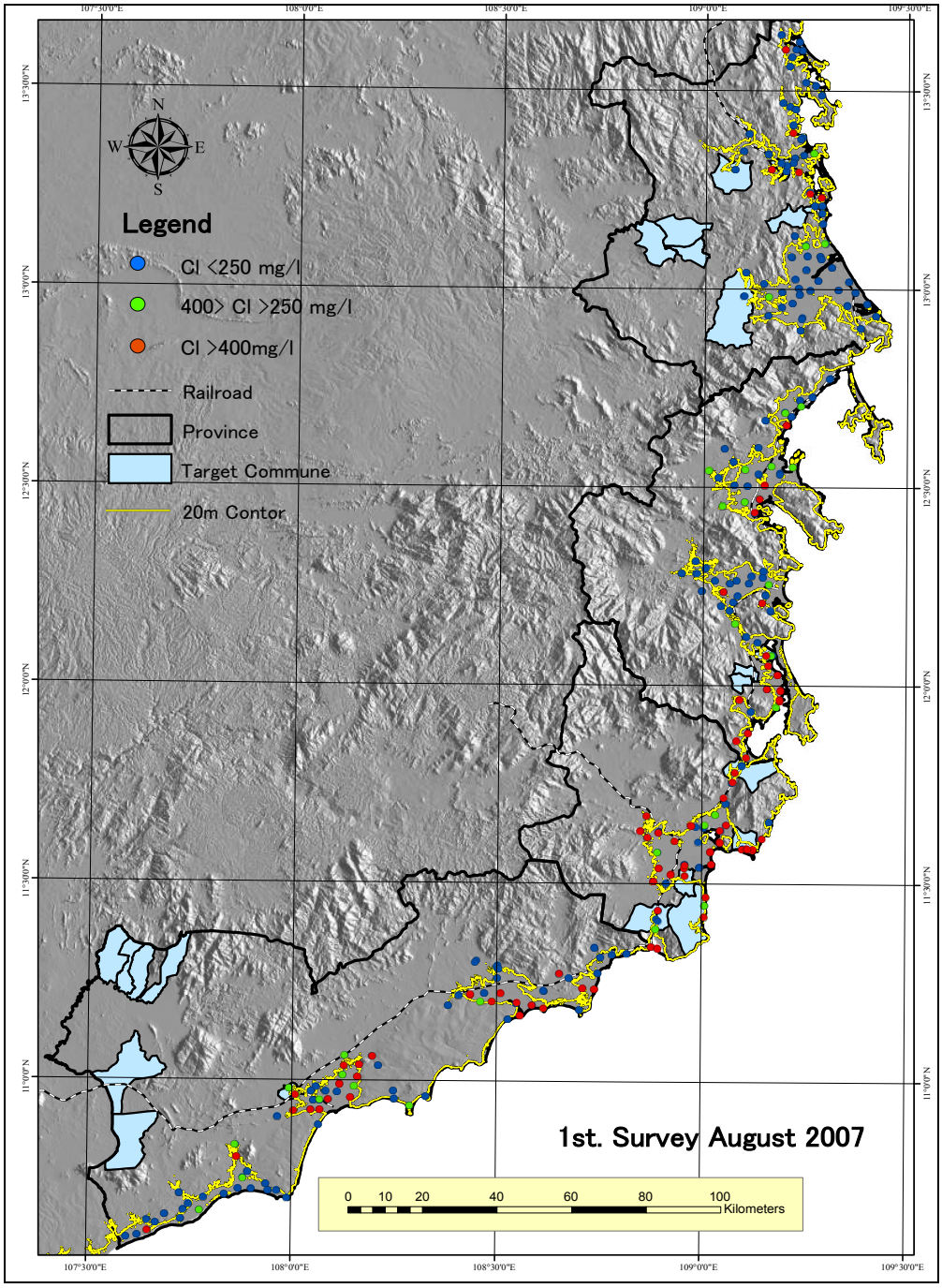


Figure 2.7.5 Salination of Dugwells in Coastal Plains in the Study Area

- Binh Thuan

  Although affected areas by seawater intrusion are found in lowland of Luy river basin in the eastern part of Binh Than province, and Tre river basin in the central part of the province where Phan Thiet is located, it's not so much than Ninh Thuan province. Only B-1 (Muong Man) is located near the affected area.

(2) Seawater Intrusion Survey in the Selected Communes

More detailed survey on seawater intrusion was conducted full day during the spring tide on 18th to

19th February 2008 in the selected nine communes: P-4, K-3, N-1 to 6 and B-1, where seemed to be affected by seawater intrusion based on the above-mentioned preparatory survey. Twenty wells: mainly dugwells, in each commune were selected for this survey.

The survey results are presented from Figure 2.7.6 to Figure 2.7.8. Electric conductivity (EC), 2,500 μS/ cm is nearly equivalent to chloride 400 mg/l. Therefore, there is a possibility that groundwater is affected by seawater intrusion in case it has higher EC value than 2,500 μS/cm.

- P-4: Elevation of ground surface is approximately five meter above seawater level (A.S.L) and groundwater level is 2.5 to 4.0 m A.S.L. Since EC values of all dugwells are low, the impact of seawater intrusion seems to be slight.
- K-3: According to the cross-section of inland side, there is no affection of seawater intrusion at all. However, seaside cross-section reveals some dugwells are affected by seawater intrusion. Elevation of their well bottoms is lower than 0m A.S.L and delicate balance between fresh water and seawater makes much difference of EC value.
- N-1: The cross section presents prominent impact in the lowland area due to seawater intrusion.
- N-2: Most of all dugwells are not affected by seawater intrusion based on EC values except No.10 dugwell, which has an extremely high value. According to its elevations of surface or well bottom and EC value of neighboring dugwells, saline water of No.10 is not caused by sweater intrusion but other sources.
- N-3: Lowland of N-3 is affected by seawater intrusion.
- N-4: Lowland of N-4 is affected considerably by seawater intrusion. Although No.2 dugwell, which is located at 30m elevation, records approximately EC 6,000 mg/l, it is not caused by seawater intrusion.
- N-5: Only No.6 dugwell shows affection of water salination; however, EC value of this commune generally is low. Therefore, the affection of seawater intrusion seems to be slight.
- N-6: Some dugwells near shoreline have high EC values caused by seawater intrusion.

B-1: No.2 dugwell in the eastmost of B-1 commune seems to be affected by seawater intrusion but there is no water salination in the eastern side of this commune, where the ground surface is gradually coming upward.

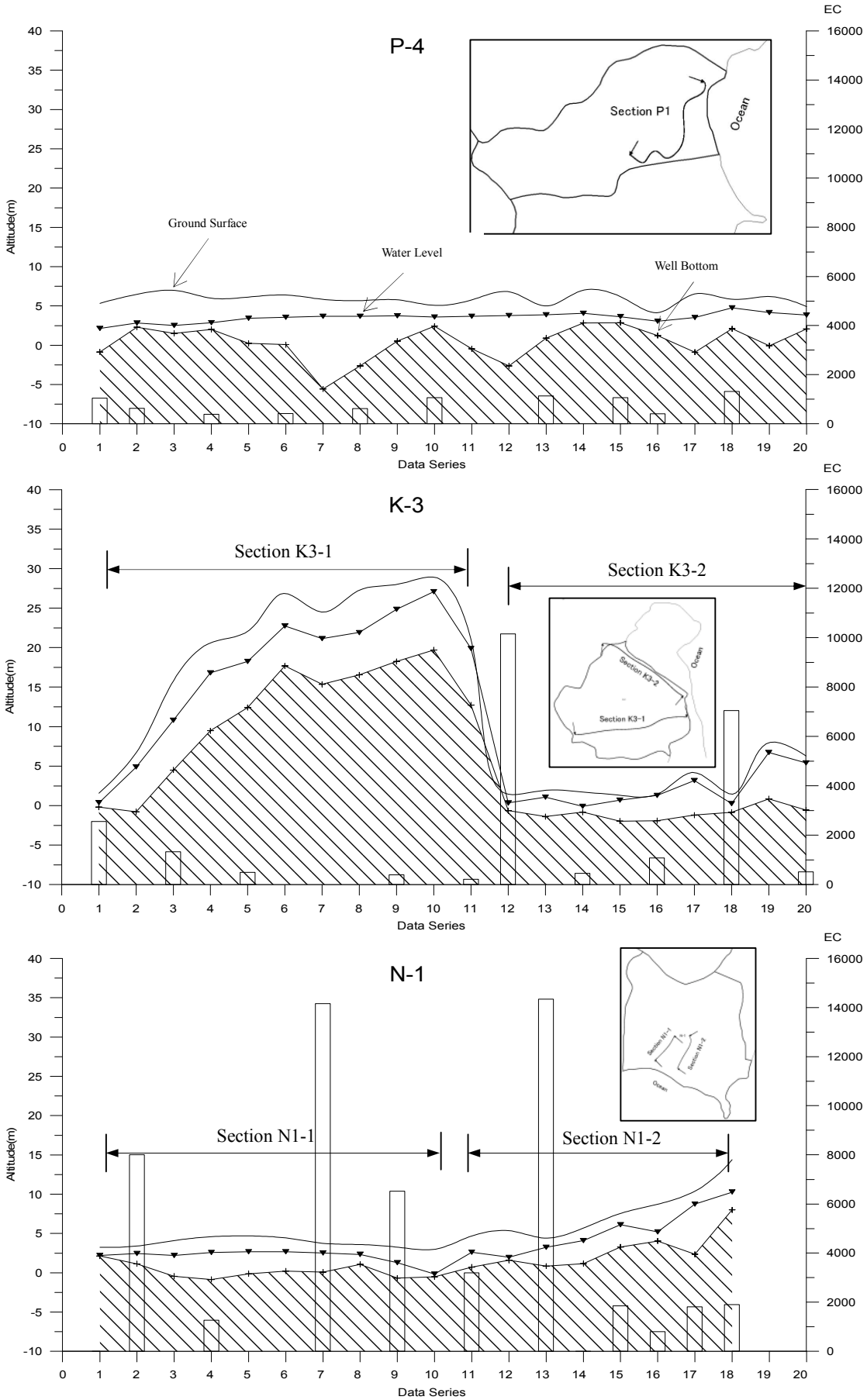


Figure 2.7.6 Relationship among Ground Level, Water Level, Well Depth and EC (1)

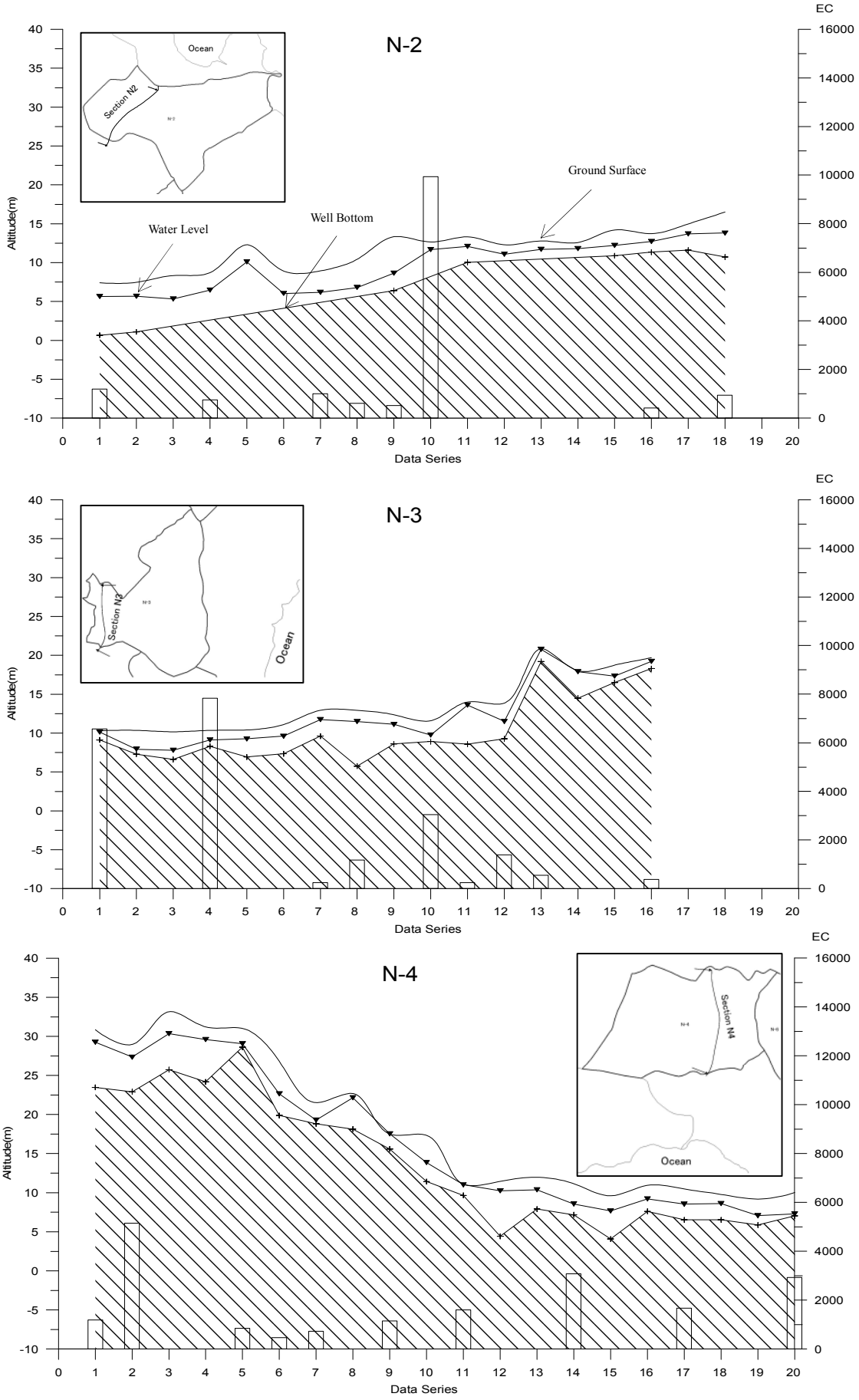


Figure 2.7.7 Relationship among Ground Level, Water Level, Well Depth and EC (2)

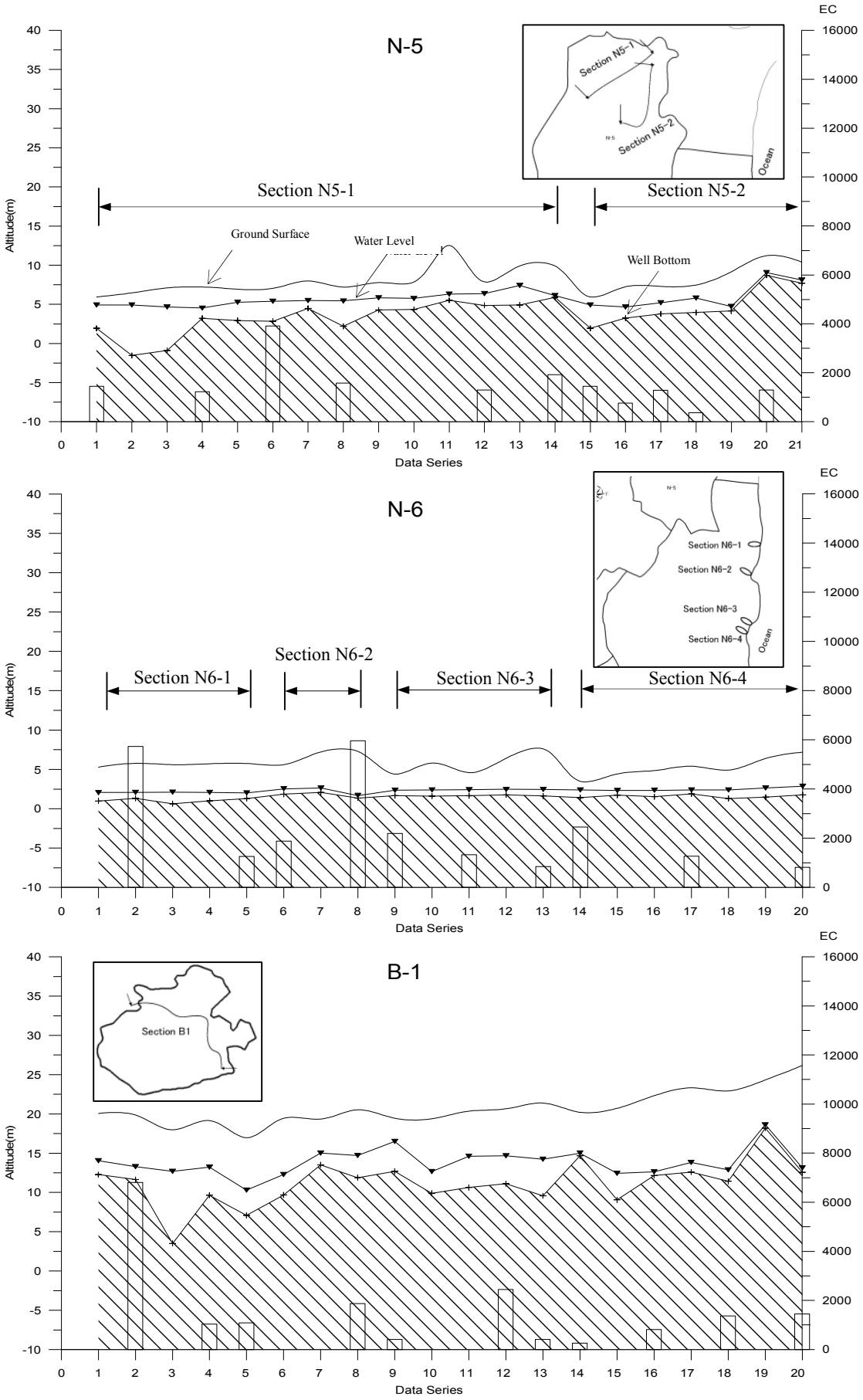


Figure 2.7.8 Relationship among Ground Level, Water Level, Well Depth and EC (3)

(3) Seawater Intrusion Analysis by Tri-linear Diagram

Tri-linear diagram was applied in order to classify water type of water sources and to know water source or in other words, groundwater recharge conditions in the target communes. Key diagram can identify five kinds of water type as shown in Figure 2.7.9 and descried below.

- Type I: $Ca(HCO_3)_2$ type

  River water and circularity groundwater fall under this type. Groundwater in limestone area is typical example.

- Type II: $Na(HCO_3)_2$ type

  Unsalted confined groundwater which is stagnating under relatively deep from ground surface is classified into this type.

- Type III: $CaSO_4$, $CaCl_2$ type

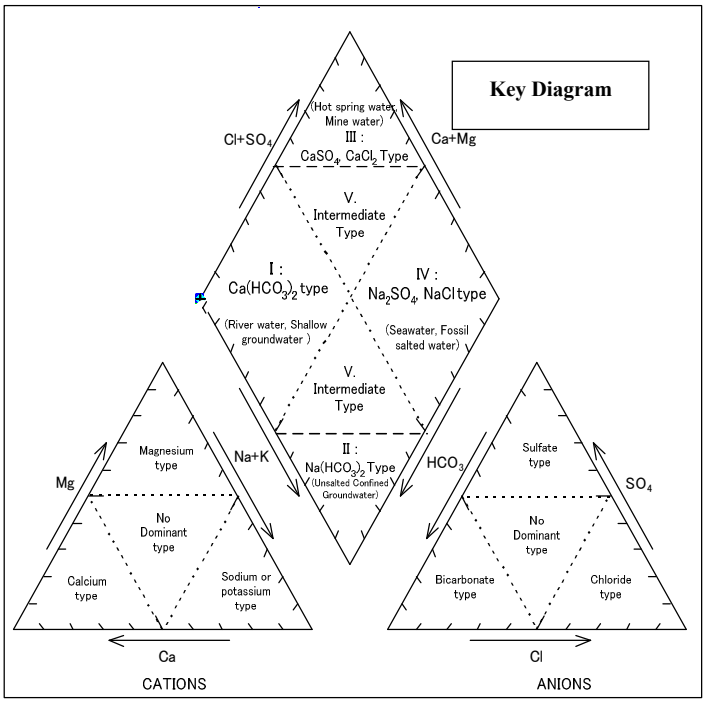
  Hot spring, mineral spring and salted fossil water correspond to this type. In the case of river water or groundwater, it is possible to be contaminated with hot spring or polluted by industrial wastewater.

- Type VI: NaCl, Na_2SO_4 type

  Seawater or groundwater and hot spring contaminated by seawater are classified into this type. Groundwater affected by seawater intrusion in the study area corresponds to this type.

- Type V: Intermediate type

  This type is intermediate of each type above mentioned. Many of river water, river-bed water and circularity groundwater are classified into Type V.



Source: Partially modified "Ground-Water Quality" by USGS:
(http://pubs.usgsgov/wri/wri0245045/htms/report2.htm)

Figure 2.7.9 Water Type Classification by Tri-linear Diagram

Water type and salinity condition of all survey points in this study is summarized in Table 2.7.3. The results of consideration are described below.

- Phu Yen Province

Although a swamp in P-4 commune seems to be slightly affected by seawater intrusion, most of all surface water in this province is categorized into Type I and there is no impact of seawater intrusion. As to groundwater, dugwells penetrated into the shallowest aquifer are also fall into Type I because the aquifer is mainly recharged with rainwater or river water. One of the dugwells in P-7 is classified into Type IV having chloride concentration of 390mg/l; however, it is not as a result of seawater intrusion because the elevation of ground surface is approximately 60m A.S.L. Three test boreholes out of eight in this province are classified into Type IV. According to chloride concentration, only P-2 Test Borehole, which is located in lowland at 9.0m A.S.L, is affected by seawater intrusion because the well reaches to the wedge.

- Khanh Hoa Province

Stream water in K-2 commune is fall into Type IV; however, affection of seawater intrusion seems to be small since the concentrating of chloride is 50ml/l only. Many of existing drilling wells and dugwells in this province are Type IV and an existing drilling well in K-3 is the only case of Type III. Since the aquifer of two test boreholes in K-1 and K-3, is not layer aquifer but fissure aquifer in the basement rocks, they have no influence of seawater intrusion at all.

- Ninh Thuan Province

There is most severe impact by seawater intrusion among four provinces. Most of all existing wells are fall into Type IV and five out of six test boreholes in Ninh Thuan province are also Type IV. Furthermore, the chloride concentration of them is extremely higher than other provinces.

- Binh Thuan Province

All test boreholes and existing drilling wells are classified into Type I which means the “First Stage” of groundwater recharge process. On the other hand, many dugwells of this province are Type IV, however their chloride concentration are very low except one of the dugwells in B-1. With taking their elevation: more than 100m A.S.L, into consideration, the cause is not seawater intrusion but elution of salinity from geological formations under the groundwater recharge process.

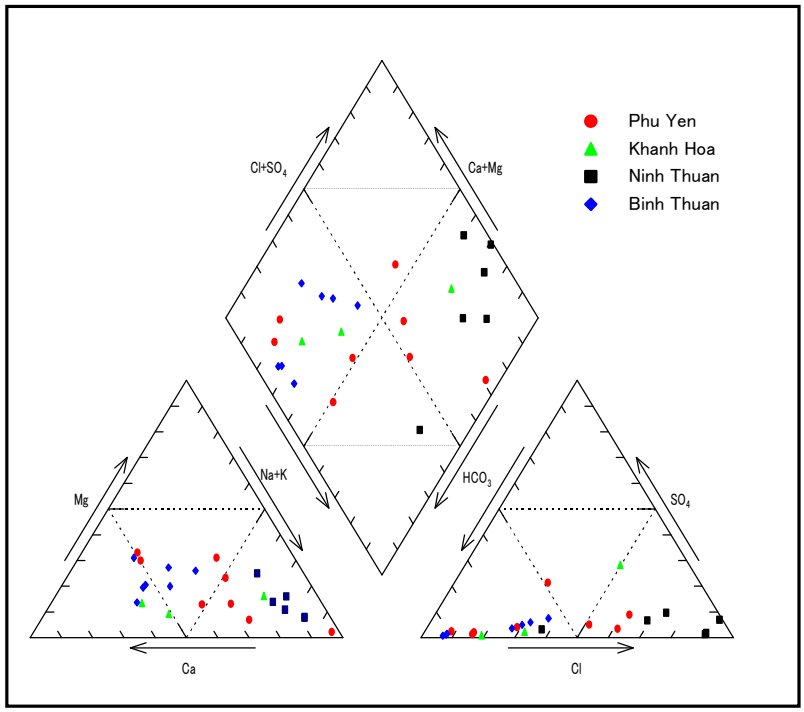


Figure 2.7.10 Tri-linear Diagrams of Test Boreholes

Table 2.7.3 Water Type of Water Resources by Commune

Province	Commune No.	Commune	Water Source																			
			Test Borehole					Dug Well					Drilled Well					Surface Water				
			Type I	Type II	Type III	Type IV	Type V	Type I	Type II	Type III	Type IV	Type V	Type I	Type II	Type III	Type IV	Type V	Type I	Type II	Type III	Type IV	Type V
Phu Yen	P-1	Xuan Phuoc	○					2									1					
	P-2	An Dinh				○		1			1	1						1				
	P-3	An Tho					○	3				1										
	P-4	An My					○	3					1			1					1	
	P-5	Son Phuoc	○					2														
	P-6	Ea Cha Rang				○		3										1				
	P-7	Suoi Bac				○		2			1							2				
	P-8	Son Thanh Don	○					2														
	Total		**3**			**3**	**2**	**18**			**2**	**2**	**1**			**1**	**1**	**4**			**1**	
Khan Hoa	K-1	Cam An Bac	○					1			1	1				1	1					
	K-2	Cam Hiep Nam				○					2					1					1	
	K-3	Cam Hai Tay	○					1			1	1			1							
	Total		**2**			**1**		**2**			**4**	**2**			**1**	**2**	**1**				**1**	
Nihn Thuan	N-1	Nhon Hai				○					4											
	N-2	Cong Hai					○				1	3										
	N-3	Bac Son				○						2				1						
	N-4	Phuoc Minh				○					4											
	N-5	Phuoc Hai				○		1			3											
	N-6	Phuoc Dinh				○		1								2	1					
	Total					**5**	**1**	**2**			**12**	**5**				**3**	**1**					
Binh Thuan	B-1	Muong Man	○					1			1		1				1					
	B-2	Gia Huynh	○					3					1									
	B-3	Nghi Duc	○								2		2									
	B-4	Tan Duc	○						1			1					2					
	B-5	Me Pu	○					1			3											
	B-6	Dung Nhon	○								4											
	B-7	Da Kai	○									1					3					
	Total		**7**					**5**	**1**		**10**	**2**	**4**				**6**					

***Type I:** $Ca(HCO_3)_2$ type (River water, Shallow groundwater), **Type II**: $Na(HCO_3)_2$ type (Unsalted Confined Groundwater),
Type III $CaSO_4$, $CaCl_2$ type (Hot spring water, Mine water), **Type IV**: Na_2SO_4, NaCl type (Seawater, Fossil salted water), **Type V**: Intermidiate type
**Number means water source number.

CHAPTER 3 MASTER PLAN OF RURAL WATER SUPPLY

3.1 Groundwater Development

A master plan of groundwater development for rural water supply in the 24 target communes is worked out as described below based on the present conditions of groundwater as described in 2.5.

3.1.1 Groundwater Development Potential

(1) Introduction

Fissure type aquifer which is difficult to exploit and develop groundwater resources is dominant in the study area. Moreover, small catchment area and short river length because of topographical characteristics lead to insufficient water resources and serious shortage of them particularly in the dry season.

In this study, the depth of target aquifer for groundwater development was decided to be shallower than 100 m as a practical exploitation depth from the economical and technical point of view. In the case of this unlike fossil water, infiltration or recharge by rain fall is the most important factor for the sustainable groundwater use. Therefore, the potential infiltration of each sub-catchment which was subdivided into 96 in and surrounding the study area was estimated by water balance analysis in order to evaluate their groundwater potentiality.

(2) Estimation Methodology of Potential Infiltration

The water balance of the study area is expressed simply by the following equation.

$$P = E + R \pm I \quad (1)$$

P: precipitation, E: evapotranspiration, R: runoff, I: infiltration.

When applying the water balance analysis, a basic unit for analysis is “sub-catchment”, and the 4 contents of water balance equation are compiled at each sub-catchment. The study area was subdivided automatically into 92 sub-catchments and 4 coastal planes by the hydrologic analysis of SRTM-3 data.

1) Precipitation

The annual and monthly precipitation analysis of the study area was based on the published atlas in Vietnam and meteorological stations data.

2) Evapotranspiration

Makkink equation (Makkink, 1957) was adopted to estimate the annual and monthly potential evapotranspiration of the study area as shown in Figure 3.1.1.

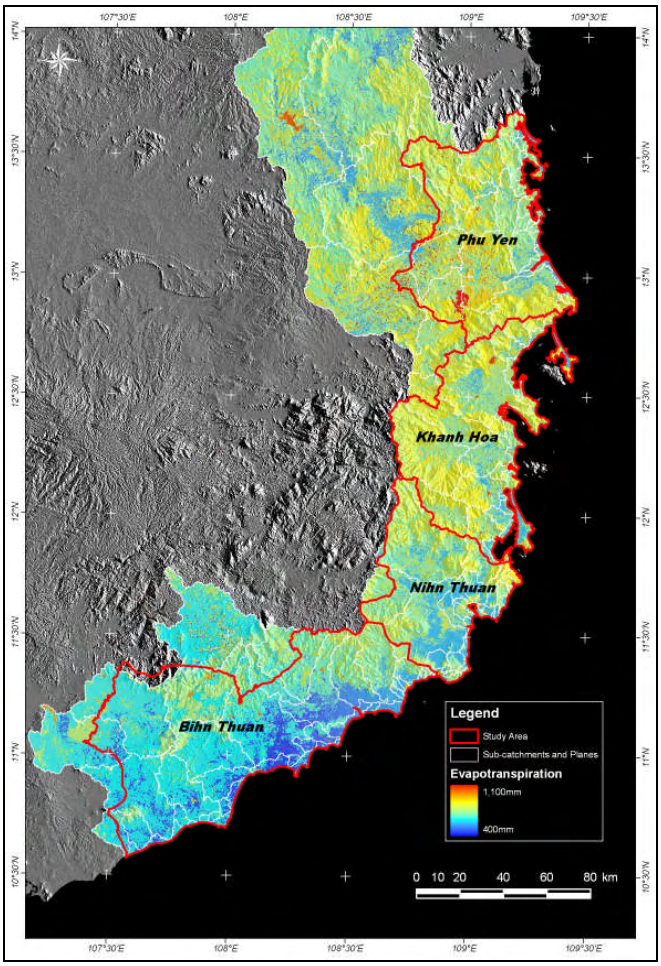


Figure 3.1.1 Distribution of Annual Evapotranspiration

3) Runoff

The ratio of runoff or river discharge was estimated by the techniques of geomorphometry. In order to examine the water flow on the land-surface, the SRTM-3 data based on geomorphometry was carried out at each sub-catchment.

There are four hydrological stations in the study area and the runoff ratio can be estimated by the monthly average water flow actually observed at these stations. In this study, the runoff ratio of the study area was estimated through the relationship between the actual runoff ratio of the stations and the result of geomorphometry in the station's sub-catchment.

(3) Distribution of Potential Infiltration

On the basis of the precipitation, evapotranspiration, and runoff ratio estimation, the potential infiltration, reflecting the groundwater recharge can be expressed by the following equation.

$$I = P - AET_{mak} - P \times R_{ratio}$$

I (mm): amount of infiltration, P (mm): amount of precipitation, AET_{mak} (mm): actual evapotranspiration value, R_{ratio}: runoff ratio.

The infiltration map of the study area is shown in the Figure 3.1.2.

The annual potential infiltration per unit area as shown in the Figure 3.1.2 indicates dominant factor for groundwater potentiality. According to the figure, Ninh Thuan and the eastern part of Binh Thuan are low groundwater potential area; especially their coastal sub-catchments show the lowest potentiality. This is also related to poor groundwater quality and seawater intrusion in Ninh Thuan. (Refer to 2.5)

On the other hand, Phu Yen and the western part of Binh Thuan have relatively high groundwater potentiality.

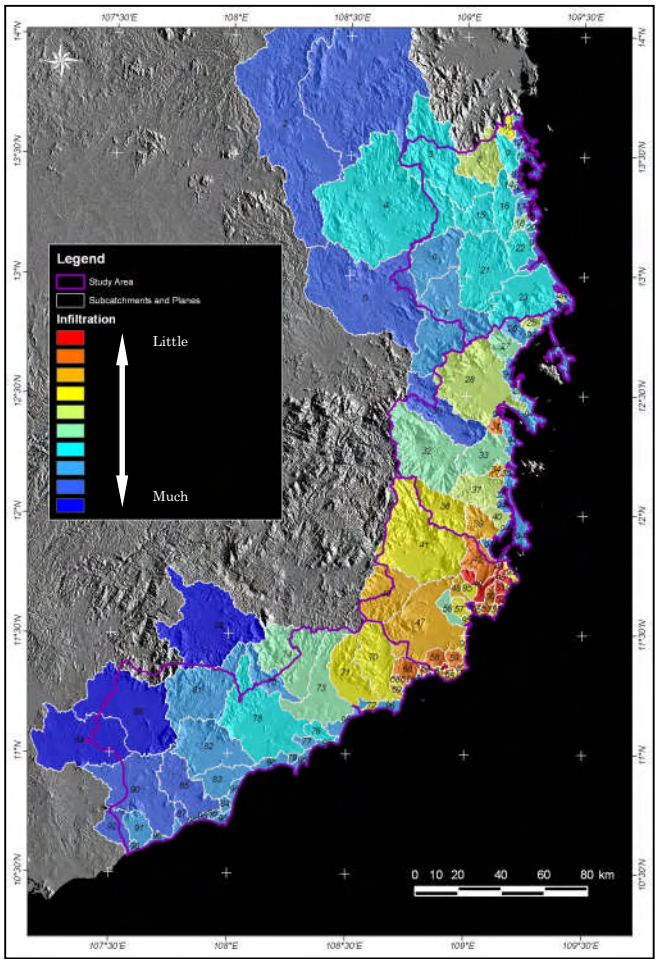


Figure 3.1.2 Distribution of Annual Potential Infiltration

3.1.2 Groundwater Potential Evaluation of Target Communes

Groundwater potential for water resource development was evaluated on the basis of the results of the hydrogeological analysis mentioned in "Chapter 2.6 Groundwater Source" and water balance analysis above mentioned. Five indices: namely, infiltration, safe yield, static water level, well depth and water quality (TDS) were selected in order to evaluate groundwater potentiality. Infiltration, which was estimated by water balance analysis, was regarded as potentiality of groundwater recharge,

was selected from hydrological point of view. These five indices were given scores by the point allocation as shown in Table 3.1.1

Difficulty of groundwater exploitation depends on not only potential infiltration but aquifer type as groundwater storage medium. Table 3.1.2 shows evaluation score of each commune by the hydrogeological investigation in this study. In the case of Binh Thuan province, the aquifer type of all target communes is classified into "fissure", therefore, it reveals that groundwater exploitation is not easy in contradiction to superior potential infiltration in the north western part of the province.

Groundwater potential evaluation of each target commune was carried out by summing up scores from six indices in total. The results of the evaluation are shown in the Table 3.1.3, which indicates high-ranked communes concentrate in Phu Yen and Khanh Hoa province, but low-ranked communes are mainly found in Ninh Thuan and Binh Thuan. Meanwhile, the score of aquifer type evaluation was weighted two times in comparison with other indices because of its importance for groundwater exploration.

Table 3.1.1 Allocation of Evaluation Scores by Each Index

Score		Evaluation Index											
		(1) Potential Infiltration ($10^3m^3/km^2$)		(2) Well Yield (m^3/day)		(3) Static Water Level (GLm)		(4) Well Depth (m)		(5) Water Quality [TDS] (mg/L)	
10	Better	1,000 <	exl.	500 <	exl.	0 <	exl.	< 30	exl.	0 - 400	exl.
9		800 - 1,000		300 - 500		-2.5 - 0		30 - 35		400 < 800	
8		600 - 800	very good	200 - 300	very good	-5 - -3	very good	35 - 40	very good	800 - 1,200	good
7		400 - 600		100 - 200		-10 - -5		40 - 45		1,200 - 1,600	
6		200 - 400	good	80 - 100	good	-15 - -10	good	45 - 50	good	1,600 - 2,000	fair
5		100 - 200		60 - 80		-20 - -15		50 - 55		2,000 - 2,500	
4		0 - 100	fair	40 - 60	fair	-30 - -20	fair	55 - 60	fair	2,500 - 3,000	poor
3		-100 - 0		20 - 40		-40 - -30		60 - 65		3,000 - 4,000	
2	Worse	-200 - -100	poor	10 - 20	poor	-50 - -40	poor	65 - 70	poor	4,000 - 5,000	Very poor
1		< -200		0 < 10		< -50		> 70		> 5,000	

Table 3.1.2 Evaluation of Aquifer Type for Groundwater Exploitation

Province	Commune Name		Target Aquifer Type of Groundwater					Total Score
			Sedimenatary Deposit	Rocks				
				Weathered	Fissure	Fractured	Porus	
Phu Yen	P-1	Xuan Phuoc		x	x		x	8
	P-2	An Dinh	x		x		x	10
	P-3	An Tho		x	x		x	8
	P-4	An My		x	x			4
	P-5	Son Phuoc		x			x	8
	P-6	Ea Cha Rang		x			x	8
	P-7	Ea Cha Rang		x			x	8
	P-8	Son Thanh Dong		x			x	8
Khanh Hoa	K-1	Cam An Bac		x	x	x		6
	K-2	Cam Hiep Nam		x	x	x		6
	K-3	Cam Hai Tay		x	x			4
Ninh Thuan	N-1	Nhon Hai	x	x				8
	N-2	Cong Hai	x	x		x		10
	N-3	Bac Son			x	x		3
	N-4	Phuoc Minh			x			1
	N-5	Phuoc Dinh	x	x				8
	N-6	Phuoc Hai				x		2
Binh Thuan	B-1	Muong Man			x			1
	B-2	Gia Huynh			x			1
	B-3	Nghi Duc			x			1
	B-4	Tan Duc			x			1
	B-5	Me Pu			x			1
	B-6	Sung Nhon			x			1
	B-7	Da Kai			x			1
Evaluation Score			5	3	1	2	4	-

Table 3.1.3 Results of Groundwater Potential Evaluation

Commune				1) Potential Infiltration		2) Safe Yield		3) Static Water Level		4) Borehole Depth		5) TDS		6) Aquifer Type	Total Evaluation	
No.	Name	Province	Area (km^2)	Value ($10^3 m^3/km^2$)	Score	Value (m^3/day)	Score	Value (GL m)	Score	Value (m)	Score	Value (mg/L)	Score	Score	*Score	Ranking
P-1	Xuan Phuoc	Phu Yen	81	394	6	6	1	-2.0	9	55	4.5	136	10	8	46.5	7
P-2	An Dinh	Phu Yen	18	316	6	288	8	-3.0	8	50	5.5	2,328	5	10	52.5	1
P-3	An Tho	Phu Yen	44	345	6	115	7	-43.5	2	65	2.5	642	9	8	42.5	15
P-4	An My	Phu Yen	14	365	6	691	10	0.8	10	75	1	264	10	4	45.0	8
P-5	Ea Cha Rang	Phu Yen	83	491	7	6	1	-6.0	7	35	8.5	392	10	8	49.5	4
P-6	Son Phuoc	Phu Yen	79	506	7	22	3	-6.0	7	65	2.5	556	9	8	44.5	9
P-7	Suoi Bac	Phu Yen	41	451	7	7	1	-7.0	7	60	3.5	490	9	8	43.5	12
P-8	Son Thanh	Phu Yen	181	387	6	432	9	-12.7	6	62	3	156	10	8	50.0	3
K-1	Cam An Bac	Khanh Hoa	21	130	5	360	9	-1.6	9	52	5	394	9	6	49.0	5
K-2	Cam Hiep Nam	Khanh Hoa	19	151	5	58	4	-6.7	7	50	5.5	232	10	6	43.5	12
K-3	Cam Hai Tay	Khanh Hoa	17	336	6	288	8	0.6	10	45	6.5	411	9	4	47.5	6
N-1	Nhon Hai	Ninh Thuan	40	-124	3	130	7	-7.0	7	59	4	1,258	7	8	44.0	11
N-2	Cong Hai	Ninh Thuan	74	-239	1	50	4	-3.5	8	29	10	642	9	10	52.0	2
N-3	Bac Son	Ninh Thuan	61	-190	2	130	7	-2.5	9	31	9	3,802	3	3	36.0	20
N-4	Phuoc Minh	Ninh Thuan	75	-108	2	1	1	-4.0	8	40	7.5	1,766	6	1	26.5	24
N-5	Phuoc Dinh	Ninh Thuan	33	-85	3	86	6	-1.3	9	36	8	32,402	1	8	43.0	14
N-6	Phuoc Hai	Ninh Thuan	130	-116	2	50	4	-6.8	7	45	6.5	862	8	2	31.5	23
B-1	Muong Man	Binh Thuan	18	406	7	36	3	-5.3	7	40	7.5	626	9	1	35.5	21
B-2	Gia Huynh	Binh Thuan	158	811	9	43	4	-1.6	9	50	5.5	224	10	1	39.5	16
B-3	Nghi Duc	Binh Thuan	38	1,150	10	4	1	-1.1	9	45	6.5	260	10	1	38.5	17
B-4	Tan Duc	Binh Thuan	137	714	8	17	2	-2.5	9	50	5.5	528	9	1	35.5	21
B-5	Me Pu	Binh Thuan	47	1,131	10	65	5	-1.9	9	35	8.5	212	10	1	44.5	9
B-6	Sung Nhon	Binh Thuan	35	1,069	10	65	5	-0.8	9	67	2	134	10	1	38.0	18
B-7	Da Kai	Binh Thuan	67	1,081	10	7	1	-5.6	7	35	8.5	156	10	1	38.5	17

*Score= 1)+2)+3)+4)+5)+2*6)

3.1.3 Groundwater Development Plan for Rural Water Supply in Target Communes

Groundwater potential in each commune is affected by local conditions and besides, candidate drilling sites of borehole for the rural water supply schemes are considerably limited in the communes. Therefore, the groundwater development plan for rural water supply in the target communes should be based on the results of test borehole drilling survey in this study. The results of test borehole drilling survey for each commune are summarized in Table 2.7.1. (Refer to "Chapter 2 Groundwater Source")

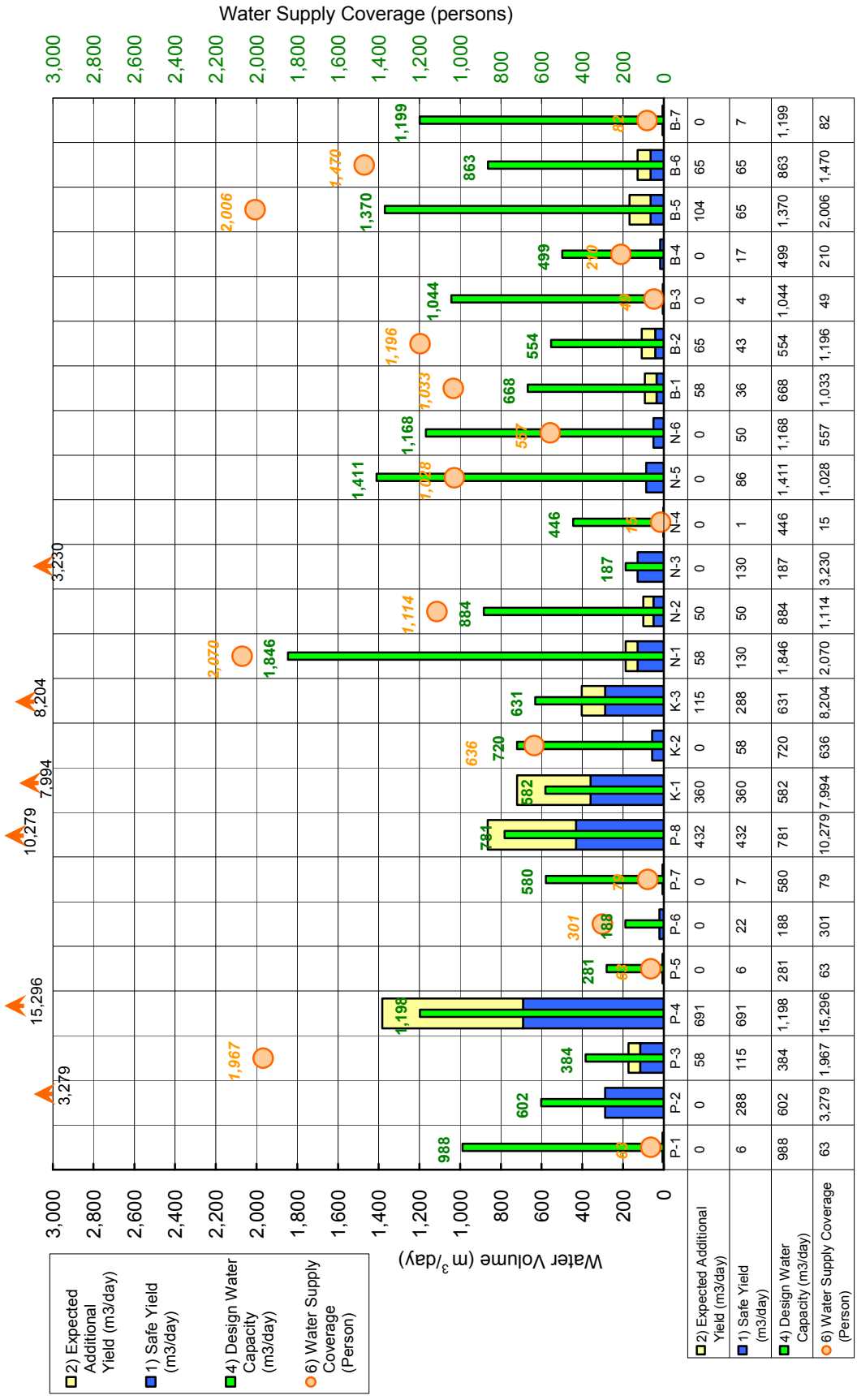
(1) Quantitative Aspect for Groundwater Development Plan

The Safe yield of each test borehole can not cover more or less entire water demand calculated in "3.2 Water Supply Plan". According to the results of the groundwater resources investigations through this study, expected yields in addition to the safe yield of the test boreholes were estimated as shown in . The figure indicates that four communes namely; P-2, 4, 8 and K-1 will be able to cover their demands in the year of 2020 by groundwater resource development with construction of necessary number of boreholes.

(2) Qualitative Aspect for Groundwater Development Plan

Table 2.7.1 also summaries qualitative aspects of groundwater in each commune based on the water quality analysis. It is clear that groundwater quality of Ninh Thuan province is bad but Binh Thuan is good. Since Fe, Mn and Zn can be removed practically, their dissatisfaction with the drinking water standards is not inhibitory matter to develop groundwater. On the other hands, it is difficult to remove Fluoride, TDS and Chloride. Then, some communes have to hang up groundwater development for drinking water supply, for example, all target communes in Ninh Thuan except for N-2.

The groundwater development plan reflected both aspects are presented in Figure 3.1.3. The communes with no expected additional yield in the figure have no groundwater resources to develop or unsuitable quality for potable water. Slim bar charts present future demand volume of water supply for each commune in 2020 and thick bar charts mean groundwater development volume. Consequently, P-4, P-8 and K-1 can cover their whole demands.



	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	K-1	K-2	K-3	N-1	N-2	N-3	N-4	N-5	N-6	B-1	B-2	B-3	B-4	B-5	B-6	B-7
2) Expected Additional Yield (m3/day)	0	0	58	691	0	0	0	432	360	0	115	58	50	0	0	0	0	58	65	0	0	104	65	0
1) Safe Yield (m3/day)	6	288	115	691	6	22	7	432	360	58	288	130	50	130	1	86	50	36	43	4	17	65	65	7
4) Design Water Capacity (m3/day)	988	602	384	1,198	281	188	580	781	582	720	631	1,846	884	187	446	1,411	1,168	668	554	1,044	499	1,370	863	1,199
6) Water Supply Coverage (Person)	63	3,279	1,967	15,296	63	301	79	10,279	7,994	636	8,204	2,070	1,114	3,230	15	1,028	557	1,033	1,196	49	210	2,006	1,470	82

Figure 3.1.3 Relationship between Water Supply Demand and Planning Borehole Yield for the Target Commne

3.1.4 Alternative Water Resource

(1) Method of Selecting Candidate Sites for Alternative Water Source

The survey on alternative water sources was conducted mainly focusing on surface water sources composed of rivers and reservoirs or ponds. Candidate sites were firstly identified based on topographic maps, satellite images and information from P-CERWASS and DARD (in case of Phu Yen).

(2) Alternative Water Source with Possibility for Water Supply

Each candidate site was mainly studied in terms of water quantity and water quality, intake condition, distance and elevation between intake places and target communes. The water quality was firstly estimated with ocular observation, EC and pH at the sites. Then the laboratory test was implemented for the selected sites with high possibility (eight sites) and marginal possibility but has other backup water sources (one site). The survey results are summarized in Table 3.1.4. The conclusion is as follows.

Table 3.1.4 Summary of Possible Surface Water Resources

Site No.	River / Reservoir	Coordinates (at observed site)	Target Commune	Distance (km) (Item 2 to 4)	Difference of Elevation (m) (Item 2 – 4)	Water Quantity during dry season	Water Quality		Possibility of Water Supply Source
							Ocular observation	Laboratory test Unsatisfied standard.	
1	2	3	4	5	6	7	8	9	10
1. Phu Yen Province									
PS-1	Phu Xuan Reservoir	13.29053 °N 109.03555 °E	P-1	3	10	Not enough	Not so bad	--	Low possibility
PS-2	Ky Lo River (Upstream reach)	13.37263 °N 108.97303 °E	P-1	13	10	Enough	Very good	Turbidity, Fe, Total coli, E-coli	**High possibility**
PS-3	Ky Lo River (Midstream reach)	13.34549 °N 109.06671 °E	P-1	5	-5	Enough	Not so good	--	**Marginal possibility**
PS-4	Dong Tron Reservoir	13.27567 °N 109.16115 °E	P-2	5	15	Enough	Probably good	Turbidity, Fe, H_2S, Total coli, E-coli	**High possibility**
PS-5	Small river	13.12818 °N 109.26200 °E	P-3	--	--	Not enough	--	--	No possibility
PS-6	Ba River	13.05220 °N 108.94560 °E	P-5, 6, 7	4 - 10	-120 - -40	Enough	Good but in case of no cyanide pollution	Turbidity, Fe, Total coli, E-coli	**High possibility** (but in case of no cyanide pollution)
PS-7	Suoi Bac River (tributary Ba R.)	13.09116 °N 108.99264 °E	P-7	2.5	36	Not enough	Good	--	No possibility
PS-8	River in P-5 (tributary Ba R.)	13.17042 °N 108.95661 °E	P-5, 6	4 - 12	-10 - +15	Not enough	Not so good	--	No possibility
2. Khanh Hoa Province									
KS-1	Cai River (in Nha Trang)	12.26101 °N 109.12584 °E	--	21 - 26	--	Enough	Good	--	-- (Reference site)
KS-2	Suoi Dau Reservoir	12.16636 °N 109.05357 °E	K-2, 3	16 - 18	0 - 20	Enough	Good	Turbidity, Fe, Total coli, E-coli	**High possibility**
KS-3	Cam Ranh Reservoir	12.09826 °N 109.09554 °E	K-2, 3	8 - 9	-10 - +10	Not enough (Water supply with 1,230 m3/day ensured)	Good	Turbidity, Fe, Total coli, E-coli	**Marginal possibility** (better to use with other water source)
3. Ninh Thuan Province									
NS-1	Song Trau Reservoir	11.80315 °N 109.06749 °E	N-1, 2, 3	3 - 25	45	Not enough	Bad		Low possibility
NS-2	Cai River at Lam Cam Weir	11.59657 °N 108.93936 °E	N-1, 2, 3 N-4, 5, 6	8 - 26	0	Enough	Good, but slightly high NH3	Turbidity, Fe, Total coli, E-coli	**High possibility**
NS-3	Cai River at Nha Trinh Weir	11.63788 °N 108.87256 °E	--	16 - 29	--	Enough	Good	--	-- (Reference site)
4. Binh Thuan Province									
BS-1	Bao Bau Reservoir	10.96631 °N 107.92632 °E	B-1	9	25	Enough	Bad	--	Low possibility
BS-2	Cam Hang Reservoir	10.99128 °N 108.04044 °E	B-1	5	10	Enough (Water supply with 1,000 m3/day ensured)	Good	Turbidity, Fe, Total coli, E-coli	**High possibility**
BS-3	La Nga River (Left Bank near Vo Xu Town)	11.19543 °N 107.59187 °E	B-3, 5, 6, 7	6 - 10	0 - 5	Enough	Good	--	-- (Reference site)
BS-4	La Nga River (Right Bank near B-6)	11.21343 °N 107.59513 °E	B-3, 5, 6, 7	4 - 9	-20	Enough	Good	Turbidity, Fe, Total coli, E-coli	**High possibility**
BS-5	La Nga River (Right Bank near B-7)	11.23943 °N 107.56582 °E	B-3, 5, 6, 7	3 - 12	-10	Enough	Good	--	**Marginal possibility**
BS-6	La Nga River (around Dong Kho Town)	11.13765 °N 107.72428 °E	B-2, 4	16 - 36	20 - 70	Enough	Good	Turbidity, Fe, Total coli, E-coli	**High possibility**
BS-7	Irrigation Pond near B-2	10.94367 °N 107.66137 °E	B-2, 4	10	0 - 50	Not enough	Not so good	--	No possibility

Note: Elevation is mainly measured by simple GPS.

3.2 Water Supply Plan

3.2.1 Study Area

The study area is located in twenty four (24) communes of four (4) provinces including Phu Yen, Khanh Hoa, Ninh Thuan and Binh Thuan. The target communes in the Study area are listed in the Table 3.2.1.

Table 3.2.1 Target Communes in the Study Area

Province	Code	Commune	Area (km^2)	Province	Code	Commune	Area (km^2)
Phu Yen	P-1	Xuan Phuoc	81.9	Ninh Thuan	N-1	Nhon Hai	20.1
	P-2	An Dinh	61.6		N-2	Cong Hai	25.4
	P-3	An Tho	40.6		N-3	Bac Son	62.9
	P-4	An My	15.4		N-4	Phuoc Minh	77.7
	P-5	Son Phuoc	28.4		N-5	Phuoc Hai	34.6
	P-6	Ea Cha Rang	82.8		N-6	Phuoc Dinh	56.8
	P-7	Suoi Bac	30.9	Binh Thuan	B-1	Muong Man	57.3
	P-8	Son Thanh Dong	37.1		B-2	Gia Huynh	39.8
Khanh Hoa	K-1	Cam An Bac	9.3		B-3	Nghi Duc	87.3
	K-2	Cam Hiep Nam	15.0		B-4	Tan Duc	28.8
	K-3	Cam Hai Tay	19.2		B-5	Me Pu	25.7
					B-6	Sung Nhon	28.2
					B-7	Da Kai	75.4

Source: Socio-economic survey by JICA study team

3.2.2 Objectives of the Study

Based on target year of NRWSSS, The target year of the Master Plan (M/P) is 2020. The prime aim of the preparation of M/P is to achieve improvement in living standards and promotion of healthy socio-economic activities through suitable project for providing clean water to the people in the study area.

The service level is considered to be 24 hours uninterrupted water supply with house connections. The rate of population served is to be 100% under the condition of sufficient water supply in 2020.

3.2.3 Water Demand

(1) Population

Table 3.2.2 summarizes the population forecast for the year 2007, 2012, 2017 and 2020. Population in the Study area until 2020 is projected on the basis of the past population records and foreseen social and economic changes.

Table 3.2.2 Population Forecast in 2007, 2012, 2017 and 2020

Province	Code	Commune	Growth Rate (%)	Population (Persons)				
				2006 (Actual)	2007	2012	2017	2020
Phu Yen	P-1	Xuan Phuoc	1.30	9,059	9,182	9,816	10,495	10,927
	P-2	An Dinh	1.00	5,964	6,022	6,326	6,654	6,856
	P-3	An Tho	2.18	3,242	3,312	3,684	4,101	4,373
	P-4	An My	1.10	11,427	11,549	12,178	12,840	13,256
	P-5	Son Phuoc	1.60	3,261	3,313	3,585	3,882	4,071
	P-6	Ea Cha Rang	1.25	2,583	2,616	2,782	2,959	3,072
	P-7	Suoi Bac	0.94	5,626	5,678	5,946	6,232	6,411
	P-8	Son Thanh Don	0.86	8,240	8,309	8,674	9,056	9,292
	Sub-total		1.20	49,402	49,981	52,991	56,219	58,258
Khanh Hoa	K-1	Cam An Bac	2.02	6,316	6,440	7,109	7,861	8,355
	K-2	Cam Hiep Nam	1.91	6,113	6,226	6,832	7,513	7,962
	K-3	Cam Hay Tay	1.40	10,620	5,825	6,245	6,693	6,978
	Sub-total		1.70	23,049	18,491	20,186	22,067	23,295
Ninh Thuan	N-1	Nhon Hai	2.30	14,896	15,234	17,048	19,079	20,413
	N-2	Cong Hai	2.00	7,381	7,530	8,324	9,203	9,776
	N-3	Bac Son	1.95	5,809	5,922	6,523	7,182	7,609
	N-4	Phuoc Minh	2.48	3,509	3,596	4,061	4,585	4,934
	N-5	Phuoc Hai	1.90	12,881	13,126	14,430	15,869	16,804
	N-6	Phuoc Dinh	4.20	8,549	8,912	10,766	12,061	12,911
	Sub-total		2.40	53,025	54,320	61,152	67,979	72,447
Binh Thuan	B-1	Muong Man	1.50	5,977	6,067	6,540	7,052	7,378
	B-2	Gia Huynh	1.13	5,246	5,305	5,611	5,936	6,139
	B-3	Nghi Duc	1.10	10,192	10,303	10,878	11,487	11,869
	B-4	Tan Duc	1.42	4,981	5,052	5,421	5,817	6,068
	B-5	Me Pu	1.50	13,250	13,449	14,488	15,603	16,315
	B-6	Suong Nhon	1.30	8,175	8,282	8,833	9,422	9,794
	B-7	Da Kai	1.60	11,436	11,615	12,556	13,590	14,263
	Sub-total		1.40	59,257	60,073	64,327	68,907	71,826
Total			1.60	184,733	182,865	198,656	215,172	225,826

(2) Water Usage

The water usage is classified into two categories as described below:

1) Domestic Water

According to National Rural Water Supply and Sanitation Strategy (NRWSS), per capita consumption is estimated to be 60 liters up to 2020. Towards achieving the target of NTP II, the ratio of population served in the target communes and per capita water consumption are defined as follows.

Year	2010	2020
Rate of population served (%)	85	100
Water demand per capita (l/ c /d)	60	60

Source: National Target Program on Rural Clean Water Supply and Sanitation (NRWSS)

As a result of the socio-economic survey, average of per capita consumption for domestic sector is

estimated to be 120 liters. Specifically for drinking, cooking and shower purposes only, the consumption is generally observed to be around 20 to 30 l/person/day. Considering these factors and conditions, the governmental target of the supply volume to be increased from the present 20-30 liter/person/day (in case of limiting to drinking, cooking and bathing) to 60 liter/person/day is judged to be appropriate and in accordance with the increased demands. Consequently, per capita consumption in this Study is considered as 60 liters/day.

2) Non-Domestic Water

In order to simplify the calculation of water demand, rate of non-domestic water consumption is calculated in case when rate of domestic water consumption is 100%. Considering this, for calculation of water demand, the figures for non domestic water consumption are classified into 3 levels as follows:

- In case when it is less than 5%: considered value for calculation is 5%
- In case when it is 6% to 10%: considered value for calculation is 10%
- In case when the value is more than 11%: considered value for calculation is 13%.

Non-domestic water consumption rate is shown in the Table 3.2.3.

Table 3.2.3 Ratio of Non-Domestic Water

Province/Commune			Non-domestic water	Province/Commune			Non-domestic water
Phu Yen	P-1	Xuan Phuoc	13%	Ninh Thuan	N-1	Nhon Hai	13%
	P-2	An Dinh	10%		N-2	Cong Hai	13%
	P-3	An Tho	10%		N-3	Bac Son	13%
	P-4	An My	13%		N-4	Phuoc Minh	13%
	P-5	Son Phuoc	13%		N-5	Phuoc Hai	5%
	P-6	Ea Cha Rang	10%		N-6	Phuoc Dinh	13%
	P-7	Suoi Bac	13%	Binh Thuan	B-1	Muong Man	13%
	P-8	Son Thanh Dong	5%		B-2	Gia Huynh	13%
Khanh Hon	K-1	Cam An Bac	10%		B-3	Nghi Duc	10%
	K-2	Cam Hiep Nam	13%		B-4	Tan Duc	10%
	K-3	Cam Hai Tay	13%		B-5	Me Pu	5%
					B-6	Sung Nhon	10%
					B-7	Da Kai	5%

Note: *1; It is recalculated by using the result of survey for water supply, 2007

3) Leakage water

The water demand forecast shall be including leakage water as a fixed percentage per day. The rate of leakage water is determined as 10% in the project.

(3) Water Demand Forecast

The water demand is estimated on the bases of the water consumption, non-domestic water and leakage water. The water demand forecast is summarized in Table 3.2.4.

Table 3.2.4 Water Demand Forecast

	Code	Commune	Water demand (Domestic, non-domestic, leakage water m^3/d)				
			2006	2007	2012	2017	2020
Phu Yen	P-1	Xuan Phuoc	683	692	740	791	823
	P-2	An Dinh	438	441	464	488	502
	P-3	An Tho	239	243	270	301	320
	P-4	An My	861	870	918	967	998
	P-5	Son Phuoc	246	250	270	292	307
	P-6	Ea Cha Rang	190	192	204	218	224
	P-7	Suoi Bac	424	428	448	470	483
	P-8	Son Thanh Don	577	582	607	633	651
Khanh Hoa	K-1	Cam An Bac	463	472	522	577	612
	K-2	Cam Hiep Nam	461	470	514	567	600
	K-3	Cam Hay Tay	800	440	471	504	526
Ninh Thuan	N-1	Nhon Hai	1,122	1,148	1,284	1,438	1,538
	N-2	Cong Hai	557	568	627	693	737
	N-3	Bac Son	438	446	491	541	573
	N-4	Phuoc Minh	264	271	307	346	371
	N-5	Phuoc Hai	902	919	1,010	1,111	1,176
	N-6	Phuoc Dinh	644	672	811	909	973
Binh Thuan	B-1	Muong Man	451	457	492	531	557
	B-2	Gia Huynh	396	399	423	447	462
	B-3	Nghi Duc	748	756	798	842	870
	B-4	Tan Duc	366	370	398	427	444
	B-5	Me Pu	928	941	1,013	1,092	1,142
	B-6	Suong Nhon	600	608	648	691	719
	B-7	Da Kai	800	813	879	951	999
Total			13,598	13,448	14,609	15,827	16,607

3.2.4 Water Supply Plan

(1) Determination of Project Scope for Master Plan

The water source for the supply system formulated in the Master Plan is basically groundwater. However, as a result of groundwater study, it is observed that in case of only 4 communes, the availability of groundwater sources is sufficient in terms of quality and quantity and hence could be used for design of water supply systems. Therefore, additional studies have been carried out to locate the alternative water sources.

Furthermore, there are some areas that are supplied water by existing piped water in 24 target communes and some areas are overlapped by water supply plan of other Donor. Analyzing the current conditions, project area for M/P formulation has been determined.

Based on the result of site investigation, pertinent area with following conditions is excluded from the selected commune under this Master Plan.

1) Areas with Existing water supply system and covered by projects of other Donor

There are 10 existing water supply systems in the target commune and Phuoc Minh commune is now carrying out tendering for the construction financed by ADB loan.

5 systems have got good sources of water availability. For the estimation of the design population, the population supplied by existing water supply is deducted from the total population in communes. On the basis of population, water demand forecast in 2020 and percentage of existing population served in Table 3.2.5, deducted population and water demand in 2020 is estimated as given below:

Table 3.2.5 Deducted Population and Water Demand in 2020

Province	Commune code	Commune	Percentage of deducted population	Deducted population	Deducted water demand (m^3/d)
Deducted area					
Phu Yen	P-5	Son Phuoc	24%	969	73
	P-6	Ea Cha Rang	30%	919	67
Khanh Hoa	K-1	Cam An Bac	21%	1,729	127
Ninh Thuan	N-3	Bac Son	73%	5,532	417
Binh Thuan	B-4	Tan Duc	6%	382	28
Deducted commune					
Ninh Thuan	N-4	Phuoc Minh	100%	4,934	371
Total				**14,465**	**1,083**

2) Non water source

In case of P-3 commune (Phu Yen province), there is no possibility to take water from the water sources in adjacent area. Hence, it is proposed to consider supplying water from the Urban Water Supply System of Thy Hoa City to P-3 commune. This commune is close to the city and therefore has not been considered for comparison of alternative water sources.

(2) Projected communes and water demand in 2020

Considering the mentioned above, 22 out of 24 communes have been included for preparation of MP in this Study and projected communes and their water demand in 2020 are shown in Table 3.2.6.

Table 3.2.6 Projected Communes and Water Demand in 2020

Province	Code	Commune	Population	Water Demand (m^3/d)	Province	Code	Commune	Population	Water Demand (m^3/d)
Phu Yen	P-1	Xuan Phuoc	10,927	823	Ninh Thuan	N-1	Nhon Hai	20,413	1,538
	P-2	An Dinh	6,856	502		N-2	Cong Hai	9776	737
	P-4	An My	13,256	998		N-3	Bac Son	2,077	156
	P-5	Son Phuoc	3,102	234		N-5	Phuoc Hai	16,804	1,176
	P-6	Ea Cha Rang	2,153	157		N-6	Phuoc Dinh	12,911	973
	P-7	Suoi Bac	6,411	483	Binh Thuan	B-1	Muong Man	7,378	557
	P-8	Son Thanh Don	9,292	651		B-2	Gia Huynh	6,139	462
Khanh Hoa	K-1	Cam An Bac	6,626	485		B-3	Nghi Duc	11,869	870
	K-2	Cam Hiep Nam	7,962	600		B-4	Tan Duc	5,686	416
	K-3	Cam Hay Tay	6,978	526		B-5	Me Pu	16,315	1,142
						B-6	Suong	9,794	719
						B-7	Da Kai	14,263	999
					Total			206,988	15,204

3.2.5 Water Supply System

(1) Pattern of water supply system

The schematic diagram illustrating pattern of the system is shown in Figure 3.2.1.

The water supply system is considered in depending on dependence upon the water source conditions. The system is classified following 3 patterns in the study.

Pattern 1: Single system

There is the water source near by water service area, the water supply system will be constructed by single facility.

Pattern 2: Group system

In case of water supply system with intake from surface water, the transmission pipeline, between water source and service area, is longer than groundwater intake. Thus, the system has advantage to be in conjunction with some nearby communes with view point of economical and technical aspects because of shared transmission pipe and intake facility.

Pattern 3: Wide area system

It is possible that there are some communes (not included among target communes) which are still lacking water supply along transmission main. It is better that future water supply plan include these communes too. The system shall be designed considering current water supply situation in these districts in a comprehensive manner. In the Master Plan, the study area is limited to target commune so the system will be provisionally designed to pick up target communes only in the wide area.

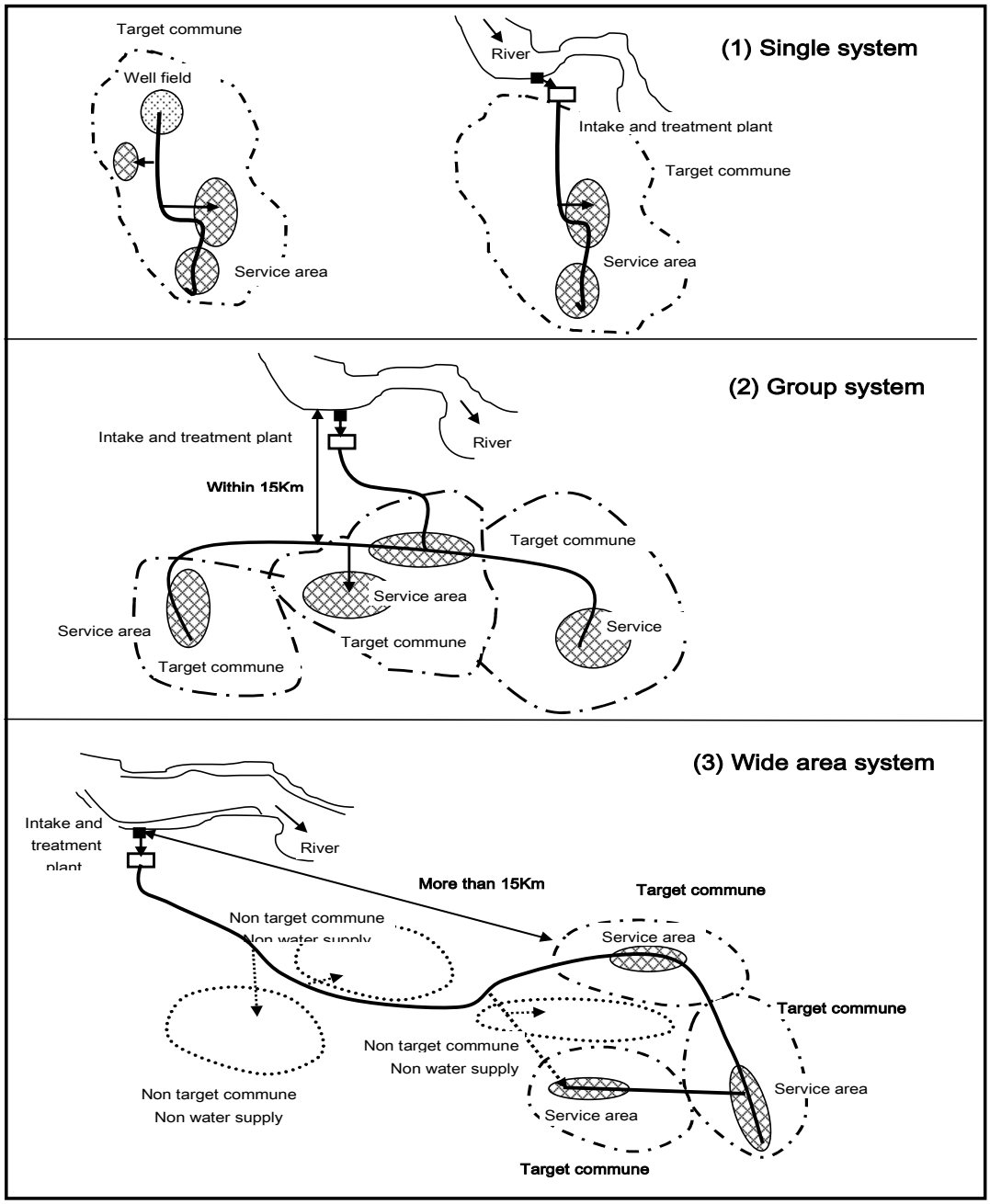


Figure 3.2.1 System Pattern

The basic conditions for water supply system, including groundwater sources and alternative water sources (surface water sources), are summarized in Table 3.2.7.

Table 3.2.7 System Pattern and Basic Conditions

Commune		System		Population in 2020	Water demand in 2020(m3/d)	Raw water source	Transmission interval (km)
		No.	Pattern				
Xuan Phuoc	P-1	FPS-1	Single	10,927	823	Ky Lo river (PS-2)	18.1
An Dinh	P-2	FPS-2	Single	6,856	502	Dong Tron reservoir (PS-4)	5.5
An My	P-4	FPS-3	Single	13,256	998	**Groundwater**	1
Son Phuoc	P-5	FPG-4	Group	11,666	874	Ba river (PS-6)	4.5
Ea Cha Rang	P-6						
Suoi Bac	P-7						
Son Thanh Don	P-8	FPS-5	Single	9,292	651	**Groundwater**	1.9
Cam An Bac	K-1	FKS-6	Single	6,626	485	**Groundwater**	0.5
Cam Hiep Nam	K-2	FKW-7	Wide area	7,962	600	Suoi Dau river (KS-2)	9.6
Cam Hay Tay	K-3	FKS-8	Single	6,978	526	**Groundwater** + Cam Ranh reservoir (KS-3) *1	1+8=9 9
Nhon Hai	N-1	FNW-9	Wide area	32,266	2,431	Cai river at Lam Com Weir (NS-2)	22,8
Cong Hai,	N-2						
Bac Son	N-3						
Phuoc Hai	N-5	FNG-10	Group	29,715	2,149	Cai river at Lam Com Weir (NS-2)	14.5
Phuoc Dinh	N-6						
Muong Man	B-1	FBS-11	Single	7,378	557	Com Hang reservoir (BS-2)	4.7
Gia Huynh	B-2	FBW-12	Wide area	11,825	878	La Nga river (BS-6)	21.4
Tan Duc	B-4						
Nghi Duc	B-3	FBG-13	Group	52,241	3,730	La Nga river (BS-4)	4.5
Me Pu	B-5						
Suong Nhon	B-6						
Da Kai	B-7						
22		13		206,988	15,204		95.2

Note: *1 The design capacity of water supply for communes with codes K-3 have been decided based on the expected yield of groundwater in accordance with results of the test borehole drilling. The differences between design capacity and the yield for these communes shall be covered by alternative water sources.

(2) Design Criteria

In order to calculate Design capacity, the values of peak factors are required. The peak factor should be compared with the Vietnamese standards, other examples and determined by existing condition of the target area. Adopted values of peak factors are as follows;

Daily peak factor : 1.2

Hourly peak factor : 2.0

(3) Design water capacity

The design capacity such as daily maximum and hourly maximum water demand is calculated, based on water demand including domestic, non-domestic and leakage water.

The design capacity in 2020 is calculated as shown in Table 3.2.8.

Table 3.2.8 Design Water Capacity in Year 2020

Province	System	Commune	Design Water Capacity		
			(1) Daily Average (m^3/d)	(2) Daily Maximum (m^3/d)	(3) Hourly Maximum (m^3/hr)
Phu Yen	FPS-1	P-1	823	1,000	82
	FPS-2	P-2	502	600	50
	FPS-3	P-4	998	1,200	100
	FPG-4	P-5,6,7	874	1,000	83
	FPS-5	P-8	651	800	67
Khanh Hoa	FKS-6	K-1	485	600	50
	FKW-7	K-2	600	700	60
	FKS-8	K-3	526	600	50
Ninh Thuan	FNW-9	N-1,2,3	2,431	3,000	243
	FNG-10	N-5,6	2,149	2,600	217
Binh Thuan	FBS-11	B-1	557	700	58
	FBW-12	B-2,4	878	1,000	88
	FBG-13	B-3,5,6,7	3,730	4,500	375
Total			15,204	18,300	

(4) Process category of the System

The process category of the system is designed by raw water quality and drinking water quality standard in Vietnam. The schematic diagram for the system of each category is indicated in Figure 3.2.2.

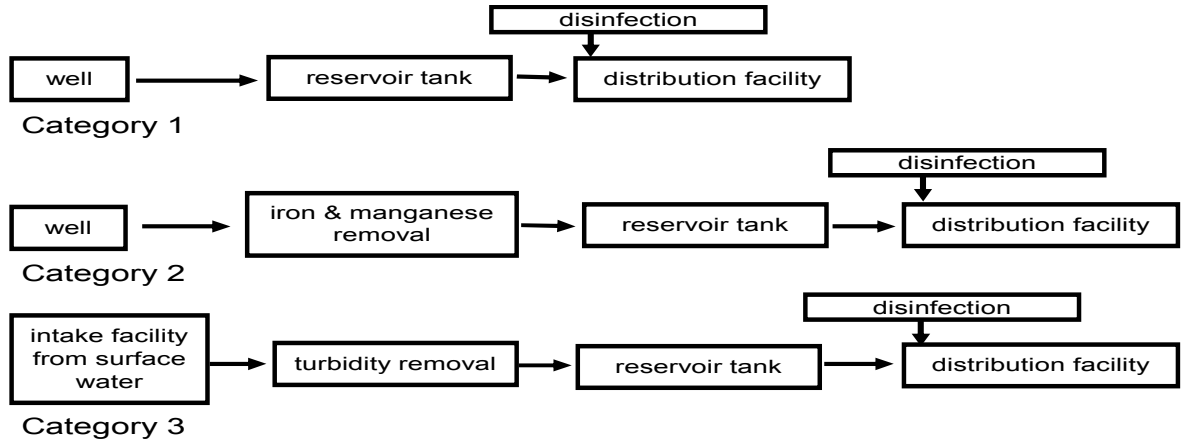


Figure 3.2.2 Category of the System

Based on the selected category, the facilities for water supply system are summarized in Table 3.2.9.

Table 3.2.9 Facility for Water Supply System

System	Process							
	Well	Intake for surface water	Non treatment	Iron remove	Turbidity remove	Reservoir tank	Distribution facility	Process category
FPS-1		X			X	X	X	3
FPS-2		X			X	X	X	3
FPS-3	X		X			X	X	1
FPG-4		X			X	X	X	3
FPS-5	X		X			X	X	1
FKS-6	X			X		X	X	2
FKW-7		X			X	X	X	3
FKS-8*1	X		X			X	X	1
FKS-8*2		X			X	X	X	3
FNW-9		X			X	X	X	3
FNG-10		X			X	X	X	3
FBS-11		X			X	X	X	3
FBW-12		X			X	X	X	3
FBG-13		X			X	X	X	3

Note : *1: Groundwater source, *2 : surface water source

3.3 Institutional Framework and Management Plan

3.3.1 Implementation System

The implementation system for the construction phase should follow the approach adopted for the "Project for the Groundwater Development in Rural Part of Northern Provinces" as grant aid project. The Project Management Unit (PMU) will be organized under the N-CERWASS, same as the one for the Northern Project, to serve as a core organization to lead implementation-related activities on the Vietnamese side.

On the one hand, primary responsibilities of P-CERWASS at this stage are to solve problems relating to acquisition of the construction site, in cooperation of the PPC, DPC and CPC, to establish a facility operation and maintenance system after completion, to promote capacity development of staffs who will be engaged in facility operation, and to construct water supply facilities to individual households.

3.3.2 Current State of O&M of Existing Water Supply Facilities

As shown in Table 3.1.1, in Vietnam, about 45% of total rural water supply systems (4,433 piped schemes in 39 Provinces/cities, capacity from 50 to 1,000 m^3/day serving for 500 to 10,000 inhabitants) are operated and maintained by P-CERWASS, and regional communes and cooperative unions also directly manage the water supply systems (28.4%) after the completion of facilities.

In the targeted Provinces of the Study, P-CERWASSs directly manage water supply facilities in Ninh Thuan and Binh Thuan Provinces. In the meanwhile, rural wafer supply facilities in Phu Yen and Khanh Hoa Provinces, after the completion, are transferred to the ownership of the CPC or other local community organization, which entrusts operation and management to local residents under the technical assistance of P-CERWASS.

Table 3.3.1 O&M Structures of Rural Water Supply

Organization	Number	(%)
P-CERWASS	**1,996**	**45.0**
Commune/Village	**1,105**	**24.9**
Cooperative Union	153	3.5
Company	36	0.8
Proprietary	140	3.2
Other form	1,033	22.6
Total	**4,433**	**(100.0)**

Source: N-CERWASS

3.3.3 Capacity Assessment

Capacities of the targeted P-CERWASSs, which play a key role of rural water supply in the four Provinces, were examined by means of generally-accepted analytical tools such as SWOT analysis and checklist of the comprehensive capacity assessment.

The results of the two assessments should be the basis of capacity development for the concerned organizations in the Study.

3.3.4 Major Issues on Operation & Maintenance (O&M)

Based on the analysis of the present facility operation and maintenance system in the previous sub-clause and the results of the past analogous projects in Northern and Central Highland Provinces, the following problems should be pointed out.

1) Especially in Phu Yen and Khan Hoa Provinces, there is no modern water supply facility in the project area.

2) In addition to 1), each P-CERWASS lacks of enough experience and know-how of the management of water supply facilities

3) In general, CPCs also lacks expertise and experience in water supply service although it is responsible for actual facility operation and periodical inspection

4) Since the ownership of the rural water supply system has been transferred from Ministry of Laibour, War Invalids and Social Affairs (MOLISA) to MARD only ten years ago, neither N-CERWASS or P-CERWASS (the core organization responsible for facility operation and maintenance) has a sufficient number of personnel who has expertise in the field.

5) N-CERWASS covers all rural water supply services throughout the country with limited staff and budget.

6) In some communes, IEC activity is not fully carried out and there is the lack of awareness of

importance of water supply among residents.

7) As for financial aspect, production cost of water varies in each water supply facility since it heavily depends on circumstances surrounding facilities such as distance between water source and water supply facilities, length of distribution pipelines, and treatment method, etc.

3.3.5 Proposed O&M structure

Basically the NRWSS and its subordinate document NTP Ⅱ recommend that new water supply facilities are operated and maintained by a commune-led organization or a local community. Indeed the communes appear to have high levels of solidifying and organizing ability as judged from activities of various local cooperatives and organizations. As pointed out earlier, however, the results of the site survey indicate that it is very difficult for local communes to operate and maintain a modern water supply system by themselves due to the shortage of human and financial resources. Thus, as shown in Figure 3.3.1, the study team recommends the establishment of the new and multi-organizational interrelated O&M system with the P-CERWASS being at the core of the structure. This arrangement is modeled after the organization adopted for the Northern and Central Highland Projects but the proposal newly adds an advisory group and involvement from the targeted communes. In a sense, prospective members of advisory group will be highly experienced organization in the water supply management.

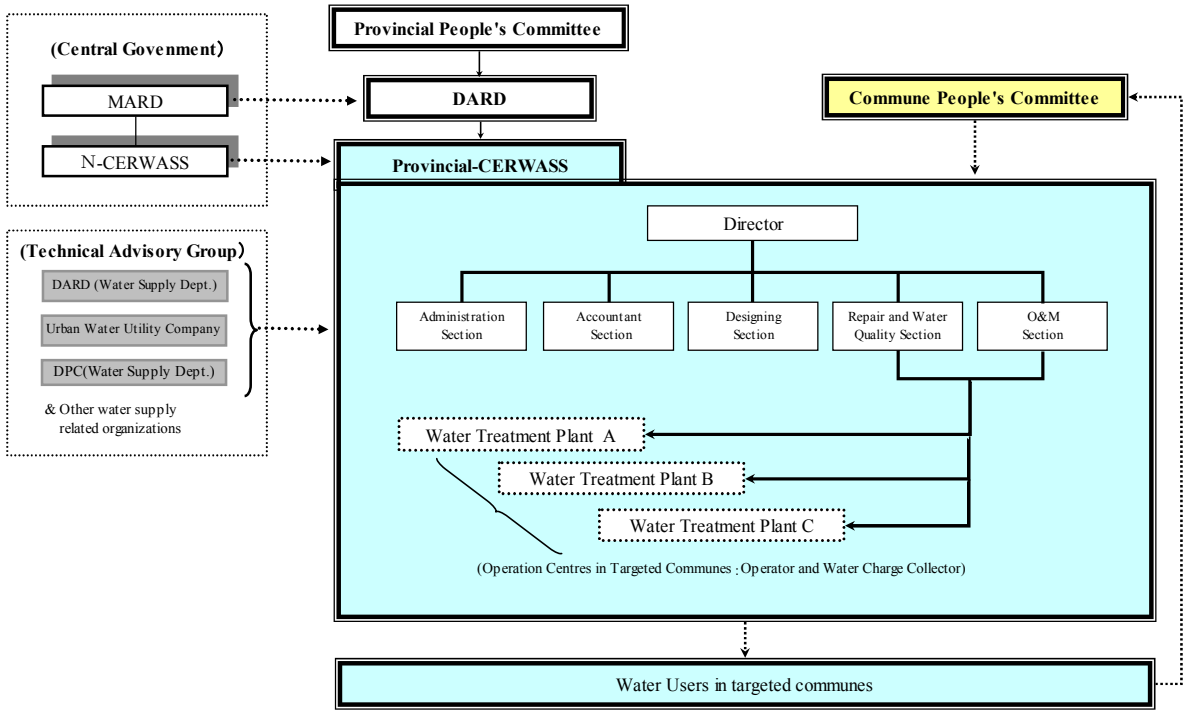


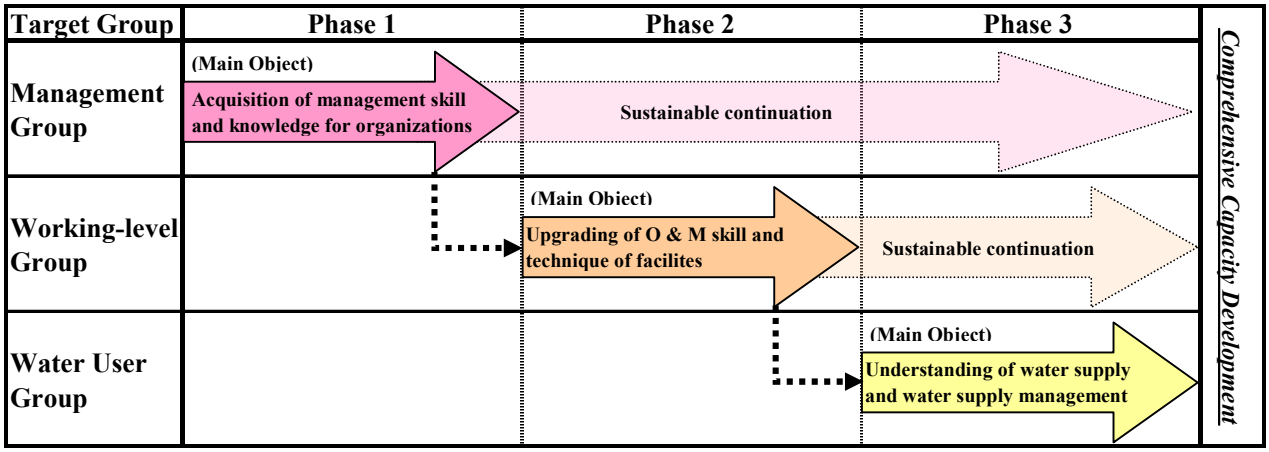
Figure 3.3.1 Proposed Organizational Structure of O&M of Water Supply Systems

3.3.6 Capacity Development Plan

(1) Background of Capacity Development

In consideration of the current situation surrounding the rural water supply in the four Provinces, CD shall be divided into the three phases for each target group such as management, working level and water user group in the Study.

Table 3.3.2 Proposed Schedule of Capacity Development in the Study



3.4 Water Supply Development

(1) Project cost

Investment plan is prepared and proposed for the water supply system for 22 communes. The systems will be classified in 3 Packages as follows;

Package	Water source /system pattern	Commune code and system No.
1	Groundwater / Single	P-4 (FPS-3), P-8 (FPS-5), K-1(FKS-6), K-3(FKS-8)
2	Surface water / Single and Group system	P-1(FPS-1), P-2(FPS-2), P-5,6,7(FPG-4), N-5,6 (FNG-10), B-1(FBS-11), B-3,5,6,7(FBG13)
3	Surface water / Wide-area system	K-2(FKW-7), N-1,2,3(FNW-9), B-2,4(FBW-12)

In single type water supply system, considering the objective of the Study, and on the basis of the result of the groundwater study as potential sources of water supply, the water supply systems for 4 communes using groundwater sources are designated as high-priority communes. Wide-area water supply system shall be investigated and designed including surrounding communes which are non water supply and non target commune in future from technical and economical viewpoints.

The estimated project cost for 13 water supply systems including 22 communes are summarized in Table 3.4.1.

Table 3.4.1 The Estimated Project Cost for each System

Package	Direct cost (x1000US$)				Indirect cost (x1000US$)		Project cost (X1000US$)
	Construction cost	Engineering service fee	Cost to be borne by Vietnam	Base cost	Contingency	VAT	
Package 1	3,742	374	411	4,527	453	412	**5,392**
Package 2	24,712	2,469	2,717	29,898	2,962	2,718	**35,578**
Package 3	11,853	1,185	1,304	14,342	1,304	1,304	**16,950**
Total in thousand US$	**40,307**	**4,029**	**4,432**	**48,767**	**4,719**	**4,434**	**57,920**
Total in million VND	679,253	6,789	74,682	760,724	79,519	74,716	914,959

Note: Exchange Rate: US$ 1=VND16, 852=JY106.17 (as of July 2008)

However, the cost of package 3 is for reference only. Because the water service areas are within the target communes only and it is uncompleted system as wide-area water supply.

(2) Schedule

The implementation schedule for 3 Packages is shown in Figure 3.4.1.

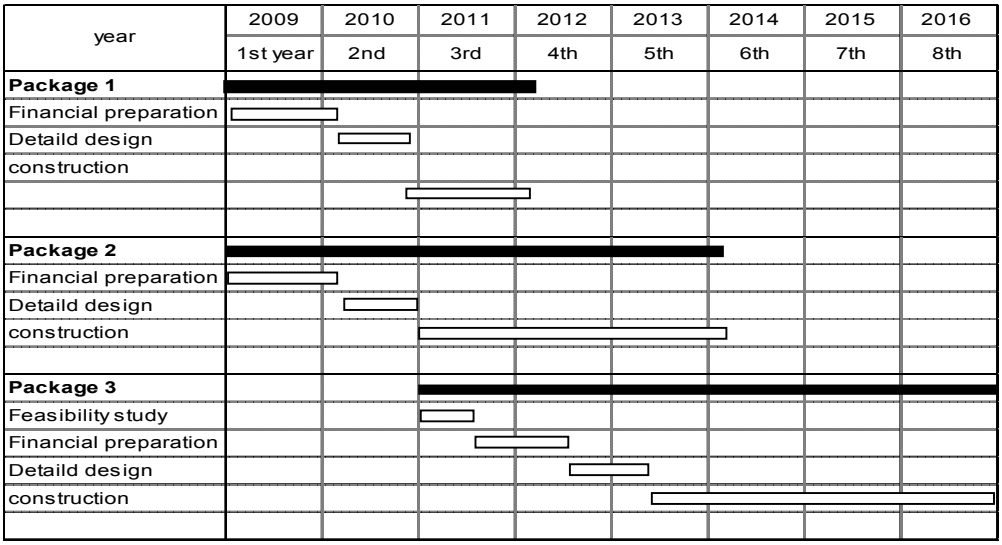


Figure 3.4.1 Implementation Schedule

The schedule is prepared and proposed based on the following conditions.

- Since total cost of Package 1 is small amount, the schedule of Package 1 and 2 is considered concurrence work schedule.
- The project size of Package 3 is tentative and it includes Feasibility Study due to required comprehensive study including neighboring communes which are non service area by piped water.
- Package 3 is scheduled after finished construction work for Package 2 due to avoid concentration of the investment.

3.5 Selection of Priority Project

(1) Basic concept

Based on communes included under Master Plan, the selection procedure of target commune for FS is shown in Figure 3.5.1.

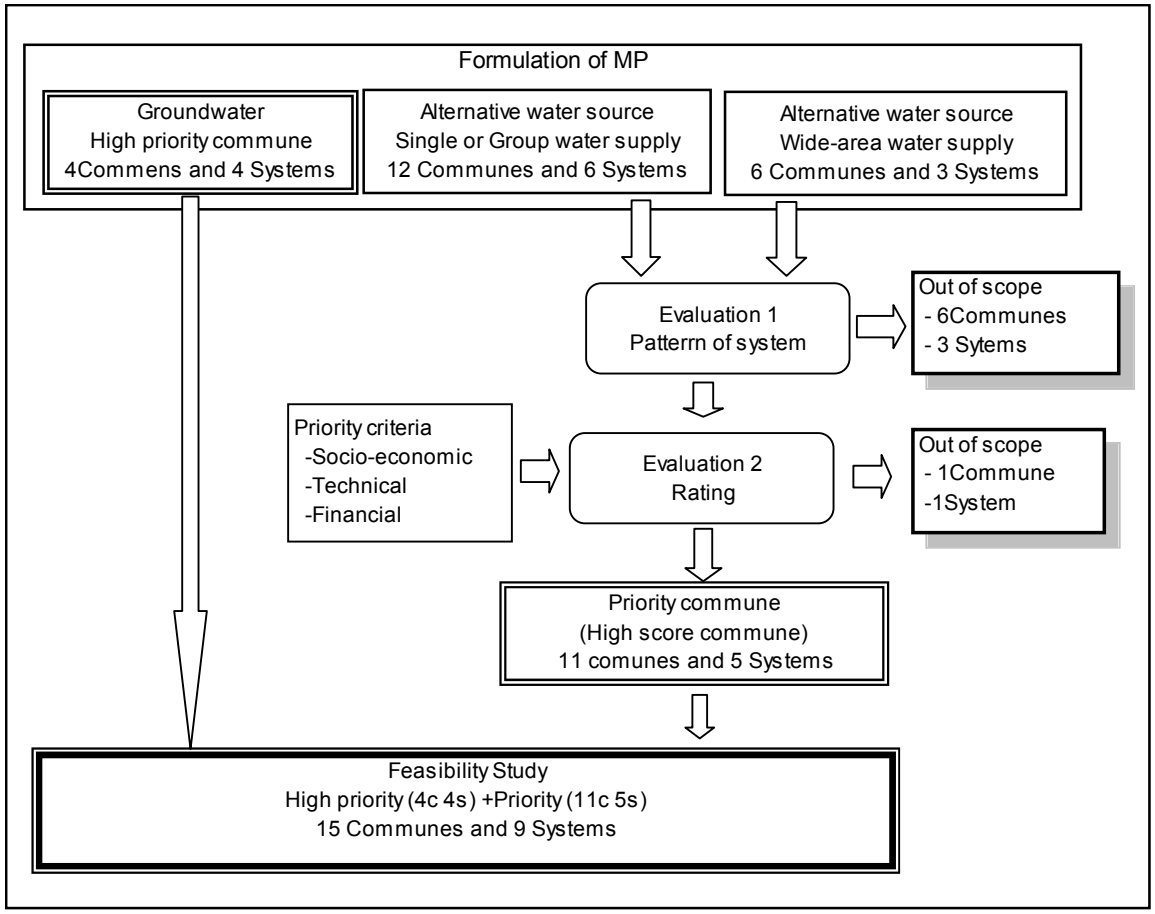


Figure 3.5.1 Selection Procedure for Priority Project

Considering the objective of the Study, the water supply systems for 4 communes using groundwater sources are designated as high-priority communes. These 4 communes are ranked as the priority communes without comparison of the commune applied by alternative water sources.

(2) Evaluation

For 18 communes, study is carried out for alternative water sources. The priority commune is formulated based on the following 2 evaluations.

Evaluation (1): Pattern of system

- There is high possibility of availability of surface water sources in and around the target communes. Water supply systems can be constructed near the water source considering Single or Group system pattern.
- Although these communes also have high possibility of availability of surface water sources, it is

better to construct water supply system including other many communes out of target communes as Wide-Area water supply from the view point of economical and technical aspects. These communes shall not be included as a part of FS.

Evaluation (2): Priority criteria

12 communes and 6 systems are evaluated based on the priority criteria. The substitute criteria for each of the six criteria are proposed. Significance of each criterion is weighted with reference to and in view of five indices of Project Evaluation prepared by the Development Assistance Committee (DAC) of the Organization for Economic Cooperation and Development (OECD). In case when criteria related to 3 out of DAC's 5 indices, they are weighted 5 points and others are weighted 3 points. Priority criteria and estimated magnitude are shown in Table 3.5.1 and Table 3.5.2.

Table 3.5.1 Priority Criteria

Socio-economic	(A) Scarcity of potable water
	(B) Effectiveness to poverty reduction
	(C) Active participation of the community
	(D) Technical rationality to install house connection using groundwater
Technical	(E) Technical conditions
Financial	(F) Financial conditions

Table 3.5.2 Estimated Magnitude of Criteria

Criteria	(i) Relevance	(ii) Effectiveness	(iii) Efficiency	(iv) Impact	(v) Sustainability	Magnitude
A Scarcity of Potable water						**11**
A1 Fetching water in dry season	X	X		X		5
A2 Rate of population served (Exisitng)	X					3
A3 Satisfaction level of available water		X		X		3
B Effectiveness to poverty reduction						**6**
B1 Rate of poverty	X	X				3
B2 Rate of ethnic minorities	X	X				3
C Active participation of the community						**6**
C1 Willingness to pay / Affordability					X	3
C2 Project ownership					X	3
D Technical rationality to install house connection						**11**
D1 Total population served	X	X	X	X		5
D2 Affordability to connection fee					X	3
D3 Rate of households having toilet					X	3
E Technical conditions for water supply system (alternative source)						**25**
E1 Raw water flow capacity	X	X	X	X	X	5
E2 Raw water quality	X	X	X	X	X	5
E3 difficulty in intake construction	X	X	X	X	X	5
E4 Distance between intake and service area	X	X	X	X	X	5
E5 Difficulty in transmission pipe construction	X	X	X	X	X	5
F Financial conditions						**5**
F1 Construction cost per m3 (VND)	X	X	X	X	X	5

Based on the criteria and magnitude, assessment score is summarized in Table 3.5.3.

Table 3.5.3 Assessment Score for the Criteria

Assessment criteria			Assessment Point		
A	Scarcity of Potable Water				
	A-1	Fetching water in dry season	5 pts more than 15 minutes	3 pts from 10 to 15 minutes	1 pt less than 10 minutes
	A-2	Rate of population served	3 pts 0%	2 pts from 1 % to 20 %	1 pt More than 21 %
	A-3	Satisfaction level of available water	3 pts more than 2.0	2 pts from 1.0 to 2.0	1 pt less than 1.0
B	Effectiveness to poverty reduction				
	B-1	Rate of poverty	3 pts more than 25 %	2 pts from 10 % to 25 %	1 pt less than 10 %
	B-2	Rate of ethnic minorities	3 pts more than 15 %	2 pts from 5 % to 15 %	1 pt less than 5 %
C	Active participation of the community				
	C-1	Willingness to pay / Affordability	3 pts more than 33,000 VND	2 pts from 20,000 VND to 33,000 VND	1 pt less than 20,000 VND
	C-2	Project ownership	3 pts Commune has an organization or experiences for O&M of water supply system.	2 pts Commune doesn't have any organization for O&M. However, Commune has planned to establish organization.	1 pt Commune doesn't have any organization for O&M and so far has no plans to establish organization.
D	Technical rationality to install house connection using groundwater				
	D-1	Total population served	5 pts more than 10,000	3 pts from 6,000 to 10,000	1 pt less than 6,000
	D-2	Affordability to connection fee	3 pts more than 400,000 VND	2 pts from 300,000 VND to 400,000 VND	1 pt less than 300,000 VND
	D-3	Rate of households having toilet	3 pts more than 50 %	2 pts from 15 % to 50 %	1 pt less than 15 %
E	Technical conditions for alternative water sources				
	E-1	Water capacity	5pts Good	3pts marginal in dry season	1pt not enough
	E-2	Water quality	5pts No treatment	3pts Requires normal treatment	1pt High risk of contaminated by heavy metal or pesticide
	E-3	Difficulty in intake construction	5pts Connection with existing pipe	3pts Connection with irrigation channel	1pt River intake
	E-4	Distance between intake and service area	5 pts Less than 10km	3 pts from 10 km to 15km	1 pt more than 15km
	E-5	Difficulty in transmission pipe construction	5pts No facility	3pts Crossing of small river or provincial road	1pt Crossing of big river or national road
F	Construction cost				
	F-1	Construction cost per population served (VND)	5 pts Less than 2 million	3 pts from 2 to 5million	1 pt more than 5 million

(3) Estimated Score and Prioritization of the Target Communes

As a result of the evaluation, the estimated scores of the water supply system for commune or system in cases of alternative source are summarized in Table 3.5.4.

Table 3.5.4 Evaluation for Water Supply System

System No.	Commune	(1) Socio-economic	(2) Technical	(3) Construction cost	(4) Total Score (4)=(1)+(2)+(3)
FPS-1	P-1	21	11	1	33
FPS-2	P-2	23	21	3	47
FPG-4	P-5,6,7	28	15	5	48
FNG-10	N-5,6	24	13	3	40
FBS-11	B-1	24	19	3	46
FBG-13	B-3,5,6,7	23	19	5	47

On the basis of result of evaluation, system Number FPS-1 is not included in the FS. This is because of the reason that the total score of the system is low compared to other systems that have points greater than 40. Especially pertaining to both condition technical and financial are low at a time. It means that transmission interval is long and degree of difficulty for construction is high. Therefore cost per cubic meter is comparatively high on price. It is decided that Feasibility Study be conducted on priority basis for 5 systems.

(4) Selection of priority system

The details on priority system including 4 high priority systems to be included in Feasibility Study are summarized in Table 3.5.4.

Table 3.5.5 System and Commune for FS

Province	Commune code No.	Commune Name	System No.	Province	Commune code No.	Commune Name	System No.
Phu Yen	P-2	An Dinh	FPS-2	Ninh Thuan	N-5,6	Phuoc Hai, Phuoc Dinh	FNG-10
	P-4	An My	FPS-3	Binh Thuan	B-1	Muong Man	FBS-11
	P-5,6,7	Son Phuoc, Ea Cha Rang, Suoi Bac	FPG—4		B-3,5,6,7	Nghi Duc, Me Pu, Sung Nhon, Da Kai	FBG-13
	P-8	Son Thanh Don	FPS-5	4	Total 15 communes		9 systems
Khan Hoa	K-1	Cam An Bac	FKS-6				
	K-3	Cam hay Tay	FKS-8				