CHAPTER 10

WATER DEMAND AND DESIGN WATER CAPACITY

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10.1 Population Forecast

The results of population forecast for each village in the 24 communes are shown from Table 10.1.2 to Table 10.1.5. The population growth rate is calculated or determined from socio-economical condition, topographical condition and development plan in each commune. Table 10.1.1 shows definition of population growth rate and its background.

Table 10.1.1 Definition of Population Growth Rate and its Background

Province/ Commune			Information on population trends (Result of discussion in workshop regarding socio-economic survey)	Details of direct/indirect factors influencing population trends, based on "Commune development plan in 2006/2007". (Industrial development, establishment of industrial plant and construction of road etc.)	Other information	Definition of population growth rate
Phu Yen	P-1	Xuan Phuoc	• Commune carries out campaign regarding family planning in order to reduce birthrate and usage rate of contraception is going up.	• Only small factory	• —	• Since campaign regarding family planning was started 5 years ago, population growth rate is calculated based on the data of population trends for the last 5 years.
	P-2	Anh Dinh	• Population growth rate is stable. • Commune carries out campaign regarding family planning in order to reduce birthrate. However, birthrate has not changed.	• None	• —	• Since commune experienced consolidation and division many times with other communes, population forecast by using past population data is difficult. Therefore, population growth rate which is analyzed and presented by CPC is adopted for population forecast in this case.
	P-3	Anh Tho	• Commune is located in the mountainous area and is not influenced much by economic activities of provincial capital. • Livelihood is through livestock and sugarcane. • Rate of seasonal migration of workers is 1~2% of commune population and is not a cause of population decrease.	• None	• —	• Commune doesn't experience any factors influencing population change. Therefore, population growth rate is calculated based on the population data of the last 10 years.
	P-4	Anh My	• Commune faces national road, which has access to provincial capital and economic activity is growing up. Number of population emigrating is small and commune has natural population growth.	• Construction plan of rice processing factory and fish sauce factory.	• —	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data of the last 10 years.
	P-5	Son Phuoc	• The rate of minority is 60%. Minority group doesn't have tendency to move • Number of seasonal migration of workers is small.	• GoV carries out program 134 to support minority people. Main purpose is water supply	• Commune was established in 1999.	• New commune • Commune experienced large population inflow. • Population growth rate in Soui May village (P-1) is adopted for this commune, since social condition and topography condition of this commune is similar to this village.
	P-6	Ea Cha Rang	• Mainly inhabited by minority people • Number of guest workers decreases.	• GoV carries out program 135 to support minority people.	• Number of villages will be changed to 6 in 2009	• Since commune experienced consolidation and division many times with other communes, population forecast from past population data is difficult. Therefore, population growth rate which is analyzed and presented by CPC is adopted for population forecast in this case.
	P-7	Suoi Bac	• 2 out of 6 villages in commune are populated by minority group.	• Number of people who carry on commercial activity increased.	• Commune experienced	• Since commune experienced consolidation and division many times with other communes, population forecast from past

Province/ Commune			Information on population trends (Result of discussion in workshop regarding socio-economic survey)	Details of direct/indirect factors influencing population trends, based on "Commune development plan in 2006/2007". （Industrial development, establishment of industrial plant and construction of road etc.）	Other information	Definition of population growth rate
				• GoV carries out program 134 to support minority people.	consolidation and division	population data is difficult. Therefore, population growth rate which is analyzed and presented by CPC is adopted for population forecast.
	P-8	Son Thanh Dong	• Commune carries out campaign regarding family planning in order to reduce birthrate. However, achievement in terms of implementation is low compared to other communes. • Number of guest workers has not changed.	• None	• Commune experienced consolidation and division in 2003	• Since commune experienced consolidation and division many times with other communes, population forecast from past population data is difficult. Therefore, population growth rate which is analyzed and presented by CPC is adopted for population forecast.
Khanh Hoa	K-1	Cam An Bac	• Population increase is constant. Depopulation has not occurred.	• None	• —	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data of the last 10 years.
	K-2	Cam Hiep Nam	• Commune is located near Cam Ranh, provincial capital. There are many opportunities of recruitment and commercial activities in this region. Therefore, number of people migrating from this area is small.	• Construction of road and sugarcane processing plant.	• —	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data of the last 10 years.
	K-3	Cam Hai Tay	• Commune is located near Cam Ranh, provincial capital. There are many opportunities of recruitment and commercial activities. Employment is stable in the sector of shrimp cultivation and depopulation has not occurred.	• Growth of business for general merchandise and handcraft sectors.	• —	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data of the last 10 years.
Ninh Thuan	N-1	Nhon Hai	• Seasonal workers who work in Thap Cham, provincial capital and urban city exist, and this does not cause population decrease.	• None	• Khanh Phuoc village will be divided into 2 villages.	• Population in this commune increased due to consolidation. Therefore, population growth rate is calculated based on the population data from 2004 onwards.
	N-2	Cong Hai	• Participants assumed that number of seasonal workers emigrating from this commune will decrease in the future, and hence population decrease will not be caused. • Number of minority people is large	• None	• Commune was established in 2001.	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data for the last 5 years.

Province/ Commune			Information on population trends (Result of discussion in workshop regarding socio-economic survey)	Details of direct/indirect factors influencing population trends, based on "Commune development plan in 2006/2007". (Industrial development, establishment of industrial plant and construction of road etc.)	Other information	Definition of population growth rate
	N-3	Bac Son	• There are many minority groups. (Cham and Lac Lay) Number of people who migrate from the area is small. • Number of seasonal workers for coffee harvesting is large. However, they return home within 2 months and this does not result into population decrease.	• None	• Commune was established in Oct 2005.	• This being new commune, past population data doesn't exist. Therefore, average of population growth rate of 2 villages, Ka Rom and Suoi Gieng in Cong Hai commune is adopted, since rate of minority people in these 2 villages is similar to the entire commune.
	N-4	Phuoc Minh	• Guest workers to work in Dalat exist and this is not expected to cause population decrease.	• None	• Commune was established in 2002	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data of the last 5 years.
	N-5	Phuoc Hai	• Thanh Tin is minority village. • Livelihood is mainly through livestock and seasonal workers exist.	• Plan of road construction around Hoa Tuy village (4.7km and 2km in total with a cost of 1.5 billion VND) • No development plans of industry	• Tu Tam village was divided in 2005.	• Tu Tam village was divided into 2 villages (Tu Tam I/II) in 2005 and population data of 2 villages doesn't exist. Therefore, population growth rate is calculated from the population data of last 10 years of Tu Tam village.

Province/ Commune			Information on population trends (Result of discussion in workshop regarding socio-economic survey)	Details of direct/indirect factors influencing population trends, based on "Commune development plan in 2006/2007". （Industrial development, establishment of industrial plant and construction of road etc.）	Other information	Definition of population growth rate
	N-6	Phuoc Dinh	• Number of shrimp cultivation farms by utilizing topography condition and its number of staffs have increased recently. • Population emigration is small, since people have many job opportunities, such as in shrimp cultivation sector.	• Construction of welding shop (4 locations), fish sauce factory (4 locations) and squid processing facility and establishment of shrimp product company	• Commune was consolidated in 1997 and 1999.	• High value of population growth rate is observed from the past population data. Commune has various development plans, therefore, population outflow is small and it is assumed that high value of population growth rate continues in the short term. (4.0%) • However, this value shall not continue in the medium and long term due to limitation of commune capacity. • As mentioned above, population growth rate calculated from the past data is adopted for future 5 years. For the later years (beyond 5 years), population growth rate in Nhon Hai (N-1) that has same topography condition is adopted. • As for Son Hai village, it was consolidated with other village in 1999 and population growth rate is calculated based on past population data from 2000 onwards. • As for Tu Thien village and Vinh Truong village, it was consolidated with other communes in 1997 and population growth rate is calculated using past population data from 1998 onwards.
Binh Thuan	B-1	Muong Man	• Commune faces national road and is located near Phan Thiet, provincial capital. Population who work for other business, such as retail business is increasing slowly. • Some of guest workers exist and they do not cause population decrease.	• Development plan doesn't exist.	• —	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data of the last 10 years.
	B-2	Gia Huynh	• Occurrence of big population inflow due to growth of economical activity in forest resources sector. • Population distribution is diffuses and there exists the plan to divide commune. • The trend of birthrate decreases.	• Construction of plant for forest industry • Construction plan of processing plant for wheat and cassava	• Commune has a plan to divide.	• It is difficult to calculate the population growth rate from the past population data due to rapid population inflow for several years. Therefore, population growth rate which is analyzed and presented by CPC is adopted for population forecast.
	B-3	Nghi Duc	• Main crop is rice. Forest industry is growing up recently. • Constant seasonal workers exist in this	• None	• —	• Commune doesn't have any specific causes for population change. Therefore, population growth rate is calculated based on the population data of the last 10 years.

Province/ Commune			Information on population trends (Result of discussion in workshop regarding socio-economic survey)	Details of direct/indirect factors influencing population trends, based on "Commune development plan in 2006/2007". (Industrial development, establishment of industrial plant and construction of road etc.)	Other information	Definition of population growth rate
			commune			
	B-4	Tan Duc	• Number of guest workers decreases. • Birthrate of households is also decreasing.	• Construction plan of multipurpose dam	• —	• Commune was established in 2004 and it is impossible to calculate the population growth rate due to unavailability of past data. Therefore, population growth rate which is analyzed and presented by CPC is adopted for population forecast.
	B-5	Me Pu	• Manufacture of brick is a booming business in this area. 300 persons work for it in commune. Number of guest workers is small. • Birthrate of each household is decreasing. • Village 9 is minority group	• Construction of road to B-3 Nghi Duc commune (4 hundred million VND) • Growth of business for general merchandise and handcraft.	• —	• Commune experienced consolidation and division many times (1998, 2000, 2001, 2003 and 2005), and it is difficult to calculate the population growth rate. • Employment condition has not changed and has been stable. Therefore, population growth rate which is presented by CPC is adopted.
	B-6	Sung Nhon	• Most of residents are located along the main road • Birthrate of households is decreasing and number of people in a family has decreased from 6 to 4 or 5. • Manufacture of brick is booming business. 125 persons work for it in commune. Number of guest workers is small.	• Construction plan of brickfield • Construction plan of road to mountain area	• —	• Since commune experienced consolidation and division many times with other communes, population forecast from past population data is difficult. Therefore, the growth rate which is analyzed and presented by CPC is adopted for population forecast.
	B-7	Da Kai	• Most of residents are located along the main road. Only village 10 is located in the mountainous area. • Number of seasonal workers is approx. 1,000 and this is not a cause of population decrease.	• Except for agriculture, number of other business, such as retail business and manufacture of brick, has increased.	• —	• It is possible to calculate population growth rate after exclusion of singular values due to consolidation and division of commune • As for Village 10, population data is missing, therefore, the growth rate which is analyzed and presented by CPC is adopted for population forecast.

＊In the case when the population growth is more than 7% compared to previous year, it is assumed that the data is incorrect or this is because of commune consolidation or population inflow, and its value is not referred for calculation of average population growth rate.

＊Basically, population growth rate is calculated based on the past population data However, in case of the commune that experiences big population inflow (P-5), the past population data is not used for population forecast and the data of other commune or village with same social conditions/ topographical conditions is adopted.

＊Guest workers are not considered to be cause of population decrease, because this kind of workers is only for off season.

Table 10.1.2 The result of population forecast for Phu Yen province

		Average Growth	Rate %	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
P-1	Xuan Phuoc	Xuan Phu A	1.70%	1,772	1,802	1,833	1,864	1,896	1,928	1,961	1,994	2,028	2,062	2,097	2,133	2,169	2,206
		Xuan Phu B	1.20%	2,755	2,788	2,821	2,855	2,889	2,924	2,959	2,995	3,031	3,067	3,104	3,141	3,179	3,217
		Phuoc Hoa	1.50%	2,819	2,861	2,904	2,948	2,992	3,037	3,083	3,129	3,176	3,224	3,272	3,321	3,371	3,422
		Phu Hoi	0.80%	1,450	1,462	1,474	1,486	1,498	1,510	1,522	1,534	1,546	1,558	1,570	1,583	1,596	1,609
		Suoi May	1.60%	386	392	398	404	410	417	424	431	438	445	452	459	466	473
		Total	1.30%	9,182	9,305	9,430	9,557	9,685	9,816	9,949	10,083	10,219	10,356	10,495	10,637	10,781	10,927
P-2	Anh Dinh	Dunh Trung I	1.00%	603	609	615	621	627	633	639	645	651	658	665	672	679	686
		Dunh Trung II	1.00%	1,193	1,205	1,217	1,229	1,241	1,253	1,266	1,279	1,292	1,305	1,318	1,331	1,344	1,357
		Dunh Trung III	1.00%	431	435	439	443	447	451	456	461	466	471	476	481	486	491
		Phong Nien	1.00%	1,330	1,343	1,356	1,370	1,384	1,398	1,412	1,426	1,440	1,454	1,469	1,484	1,499	1,514
		Phong Hanh	1.00%	335	338	341	344	347	350	354	358	362	366	370	374	378	382
		Phong Thang	1.00%	349	352	356	360	364	368	372	376	380	384	388	392	396	400
		Phong Hau	1.00%	1,029	1,039	1,049	1,059	1,070	1,081	1,092	1,103	1,114	1,125	1,136	1,147	1,158	1,170
		Long Hoa	1.00%	752	760	768	776	784	792	800	808	816	824	832	840	848	856
		Total	1.00%	6,022	6,081	6,141	6,202	6,264	6,326	6,391	6,456	6,521	6,587	6,654	6,721	6,788	6,856
P-3	Anh Tho	Phu Can	2.20%	1,354	1,384	1,414	1,445	1,477	1,509	1,542	1,576	1,611	1,646	1,682	1,719	1,757	1,796
		Phu My	2.00%	708	722	736	751	766	781	797	813	829	846	863	880	898	916
		Lam Son	2.30%	586	599	613	627	641	656	671	686	702	718	735	752	769	787
		Kim Son	2.00%	371	378	386	394	402	410	418	426	435	444	453	462	471	480
		Quang Duc	2.30%	293	300	307	314	321	328	336	344	352	360	368	376	385	394
		Total	2.18%	3,312	3,383	3,456	3,531	3,607	3,684	3,764	3,845	3,929	4,014	4,101	4,189	4,280	4,373
P-4	Anh My	Hoa Da	1.20%	4,319	4,371	4,423	4,476	4,530	4,584	4,639	4,695	4,751	4,808	4,866	4,924	4,983	5,043
		Phu Long	1.00%	2,998	3,028	3,058	3,089	3,120	3,151	3,183	3,215	3,247	3,279	3,312	3,345	3,378	3,412
		Giai Son	1.00%	3,153	3,185	3,217	3,249	3,281	3,314	3,347	3,380	3,414	3,448	3,482	3,517	3,552	3,588
		Phu Hoa	0.80%	703	709	715	721	727	733	739	745	751	757	763	769	775	781
		Tan Lap	1.10%	376	380	384	388	392	396	400	404	408	412	417	422	427	432
		Total	1.10%	11,549	11,673	11,797	11,923	12,050	12,178	12,308	12,439	12,571	12,704	12,840	12,977	13,115	13,256
P-5	Son Phuoc	Ma Gu	1.60%	331	336	341	346	352	358	364	370	376	382	388	394	400	406
		Tan Hien	1.60%	428	435	442	449	456	463	470	478	486	494	502	510	518	526
		Tan Hoa	1.60%	1,256	1,276	1,296	1,317	1,338	1,359	1,381	1,403	1,425	1,448	1,471	1,495	1,519	1,543
		Tan Binh	1.60%	509	517	525	533	542	551	560	569	578	587	596	606	616	626
		Hon Ong	1.60%	789	802	815	828	841	854	868	882	896	910	925	940	955	970
		Total	1.60%	3,313	3,366	3,419	3,473	3,529	3,585	3,643	3,702	3,761	3,821	3,882	3,945	4,008	4,071
P-6	Ea Cha Rang	Kien Thiet	1.25%	1,176	1,191	1,206	1,221	1,236	1,251	1,267	1,283	1,299	1,315	1,331	1,348	1,365	1,382
		Doc Lap A	1.25%	382	387	392	397	402	407	412	417	422	427	432	437	442	448
		Doc Lap B	1.25%	258	261	264	267	270	273	276	279	282	286	290	294	298	302
		Doc Lap C	1.25%	800	810	820	830	840	851	862	873	884	895	906	917	928	940
		Total	1.25%	2,616	2,649	2,682	2,715	2,748	2,782	2,817	2,852	2,887	2,923	2,959	2,996	3,033	3,072
P-7	Suoi Bac	Tan Lap	0.94%	450	454	458	462	466	470	474	478	482	487	492	497	502	507
		Tan An	0.94%	641	647	653	659	665	671	677	683	689	695	702	709	716	723
		Tan Thanh	0.94%	868	876	884	892	900	908	917	926	935	944	953	962	971	980
		Tan Phu	0.94%	1,647	1,662	1,678	1,694	1,710	1,726	1,742	1,758	1,775	1,792	1,809	1,826	1,843	1,860
		Phu Huu	0.94%	474	478	482	487	492	497	502	507	512	517	522	527	532	537
		Suoi Bac	0.94%	1,598	1,613	1,628	1,643	1,658	1,674	1,690	1,706	1,722	1,738	1,754	1,770	1,787	1,804
		Total	0.94%	5,678	5,730	5,783	5,837	5,891	5,946	6,002	6,058	6,115	6,173	6,232	6,291	6,351	6,411
P-8	Son Thanh Dong	Than Binh Dong	0.86%	511	515	519	523	527	532	537	542	547	552	557	562	567	572
		Phu Thinh	0.86%	1,326	1,337	1,348	1,360	1,372	1,384	1,396	1,408	1,420	1,432	1,444	1,456	1,469	1,482
		Le Loc Binh	0.86%	1,000	1,009	1,018	1,027	1,036	1,045	1,054	1,063	1,072	1,081	1,090	1,099	1,108	1,118
		Binh Thang	0.86%	1,098	1,107	1,117	1,127	1,137	1,147	1,157	1,167	1,177	1,187	1,197	1,207	1,217	1,227
		My Binh	0.86%	1,580	1,594	1,608	1,622	1,636	1,650	1,664	1,678	1,692	1,707	1,722	1,737	1,752	1,767
		Lac Dien	0.86%	1,431	1,443	1,455	1,468	1,481	1,494	1,507	1,520	1,533	1,546	1,559	1,572	1,586	1,600
		Truong Thanh	0.86%	845	852	859	866	873	881	889	897	905	913	921	929	937	945
		Thanh An	0.86%	518	522	526	531	536	541	546	551	556	561	566	571	576	581
		Total	0.86%	8,309	8,379	8,450	8,524	8,598	8,674	8,750	8,826	8,902	8,979	9,056	9,133	9,212	9,292
Phu Yen		Total	1.20%	49,981	50,566	51,158	51,762	52,372	52,991	53,624	54,261	54,905	55,557	56,219	56,889	57,568	58,258

Table 10.1.3 The result of population forecast for Khanh Hoa province

		Average Growth	Rate %	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
K-1	Cam An Bac	Hien Luong	0.80%	1,261	1,271	1,281	1,291	1,301	1,311	1,321	1,332	1,343	1,354	1,365	1,376	1,387	1,398
		Thuy Ba	2.60%	1,163	1,193	1,224	1,256	1,289	1,323	1,357	1,392	1,428	1,465	1,503	1,542	1,582	1,623
		Trieu Hai	1.20%	1,279	1,294	1,310	1,326	1,342	1,358	1,374	1,390	1,407	1,424	1,441	1,458	1,475	1,493
		Cua Tung	2.60%	1,397	1,433	1,470	1,508	1,547	1,587	1,628	1,670	1,713	1,758	1,804	1,851	1,899	1,948
		Tan An	2.70%	1,340	1,376	1,413	1,451	1,490	1,530	1,571	1,613	1,657	1,702	1,748	1,795	1,843	1,893
		Total	2.02%	6,440	6,567	6,698	6,832	6,969	7,109	7,251	7,397	7,548	7,703	7,861	8,022	8,186	8,355
K-2	Cam Hiep Nam	Quang Duc	0.90%	1,579	1,593	1,607	1,621	1,636	1,651	1,666	1,681	1,696	1,711	1,726	1,742	1,758	1,774
		Suoi Cat	2.90%	2,704	2,782	2,863	2,946	3,031	3,119	3,209	3,302	3,398	3,497	3,598	3,702	3,809	3,919
		Vinh Thai	1.20%	1,943	1,966	1,990	2,014	2,038	2,062	2,087	2,112	2,137	2,163	2,189	2,215	2,242	2,269
		Total	1.91%	6,226	6,341	6,460	6,581	6,705	6,832	6,962	7,095	7,231	7,371	7,513	7,659	7,809	7,962
K-3	Cam Hai Tay	Bai Gieng I	1.30%	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Bai Gieng II	1.30%	2,375	2,406	2,437	2,469	2,501	2,534	2,567	2,600	2,634	2,668	2,703	2,738	2,774	2,810
		Tan Hai	1.40%	1,276	1,294	1,312	1,330	1,349	1,368	1,387	1,406	1,426	1,446	1,466	1,487	1,508	1,529
		Bac Vinh	1.50%	2,174	2,207	2,240	2,274	2,308	2,343	2,378	2,414	2,450	2,487	2,524	2,562	2,600	2,639
		Total	1.40%	5,825	5,907	5,989	6,073	6,158	6,245	6,332	6,420	6,510	6,601	6,693	6,787	6,882	6,978
Khanh Hoa		**Total**	1.70%	18,491	18,815	19,147	19,486	19,832	20,186	20,545	20,912	21,289	21,675	22,067	22,468	22,877	23,295

Table 10.1.4 The result of population forecast for Ninh Thuan province

		Average Growth	Rate %	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
N-1	Nhon Hai	Khanh Nhon	2.10%	4,825	4,926	5,029	5,135	5,243	5,353	5,465	5,580	5,697	5,817	5,939	6,064	6,191	6,321
		Khanh Phuoc	2.10%	2,732	2,789	2,848	2,908	2,969	3,031	3,095	3,160	3,226	3,294	3,363	3,434	3,506	3,580
		My Tuong I	2.40%	3,986	4,082	4,180	4,280	4,383	4,488	4,596	4,706	4,819	4,935	5,053	5,174	5,298	5,425
		My Tuong II	2.50%	3,691	3,783	3,878	3,975	4,074	4,176	4,280	4,387	4,497	4,609	4,724	4,842	4,963	5,087
		Total	2.30%	15,234	15,580	15,935	16,298	16,669	17,048	17,436	17,833	18,239	18,655	19,079	19,514	19,958	20,413
N-2	Cong Hai	Hiep Kiet	2.70%	1,180	1,212	1,245	1,279	1,314	1,349	1,385	1,422	1,460	1,499	1,539	1,581	1,624	1,668
		Hiep Thanh	1.60%	329	334	339	344	350	356	362	368	374	380	386	392	398	404
		Suoi Vang	1.80%	2,038	2,075	2,112	2,150	2,189	2,228	2,268	2,309	2,351	2,393	2,436	2,480	2,525	2,570
		Suoi Gieng	1.90%	2,058	2,097	2,137	2,178	2,219	2,261	2,304	2,348	2,393	2,438	2,484	2,531	2,579	2,628
		Som Den	2.00%	700	714	728	743	758	773	788	804	820	836	853	870	887	905
		Ka Rom	2.00%	982	1,002	1,022	1,042	1,063	1,084	1,106	1,128	1,151	1,174	1,197	1,221	1,245	1,270
		Binh Tien	2.40%	243	249	255	261	267	273	280	287	294	301	308	315	323	331
		Total	2.00%	7,530	7,683	7,838	7,997	8,160	8,324	8,493	8,666	8,843	9,021	9,203	9,390	9,581	9,776
N-3	Bac Son	Binh Nghia	1.95%	1,424	1,452	1,480	1,509	1,538	1,568	1,599	1,630	1,662	1,694	1,727	1,761	1,795	1,830
		Xom Bang	1.95%	2,295	2,340	2,386	2,433	2,480	2,528	2,577	2,627	2,678	2,730	2,783	2,837	2,892	2,948
		Lang Me	1.95%	2,203	2,246	2,290	2,335	2,381	2,427	2,474	2,522	2,571	2,621	2,672	2,724	2,777	2,831
		Total	1.95%	5,922	6,038	6,156	6,277	6,399	6,523	6,650	6,779	6,911	7,045	7,182	7,322	7,464	7,609
N-4	Phuoc Minh	Lac Tien	2.40%	2,220	2,273	2,328	2,384	2,441	2,500	2,560	2,621	2,684	2,748	2,814	2,882	2,951	3,022
		Quan The1	2.60%	1,090	1,118	1,147	1,177	1,208	1,239	1,271	1,304	1,338	1,373	1,409	1,446	1,484	1,523
		Quan The2	2.40%	286	293	300	307	314	322	330	338	346	354	362	371	380	389
		Total	2.48%	3,596	3,684	3,775	3,868	3,963	4,061	4,161	4,263	4,368	4,475	4,585	4,699	4,815	4,934
N-5	Phuoc Hai	Thanh Tin	1.80%	4,663	4,747	4,832	4,919	5,008	5,098	5,190	5,283	5,378	5,475	5,574	5,674	5,776	5,880
		Hoa Thuy	2.80%	2,065	2,123	2,182	2,243	2,306	2,371	2,437	2,505	2,575	2,647	2,721	2,797	2,875	2,956
		Tu Tam I	1.70%	4,351	4,425	4,500	4,577	4,655	4,734	4,814	4,896	4,979	5,064	5,150	5,238	5,327	5,418
		Tu Tam II	1.70%	2,047	2,082	2,117	2,153	2,190	2,227	2,265	2,304	2,343	2,383	2,424	2,465	2,507	2,550
		Total	1.90%	13,126	13,377	13,631	13,892	14,159	14,430	14,706	14,988	15,275	15,569	15,869	16,174	16,485	16,804
N-6	Phuoc Dinh	Tu Thien	4.70%	1,187	1,243	1,301	1,362	1,426	1,459	1,493	1,527	1,562	1,598	1,635	1,673	1,711	1,750
	＊2012年以降は	Vinh Truong	3.90%	543	564	586	609	633	648	663	678	694	710	726	743	760	777
	2.3%増加率適月	Bau Ngu	3.90%	227	236	245	255	265	271	277	283	290	297	304	311	318	325
		Son Hai 1	4.20%	4,558	4,749	4,948	5,156	5,373	5,497	5,623	5,752	5,884	6,019	6,157	6,299	6,444	6,592
		Son Hai 2	4.20%	2,397	2,498	2,603	2,712	2,826	2,891	2,957	3,025	3,095	3,166	3,239	3,313	3,389	3,467
		Total	4.20%	8,912	9,290	9,683	10,094	10,523	10,765	11,013	11,266	11,525	11,790	12,061	12,338	12,622	12,912
Ninh Thuan		Total	2.40%	54,320	55,652	57,018	58,426	59,873	61,151	62,459	63,795	65,161	66,555	67,979	69,437	70,925	72,448

Table 10.1.5 The result of population forecast for Binh Thuan province

		Average Growth	Rate %	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
B-1	Muong Man	Dang Thanh	1.40%	2,237	2,268	2,300	2,332	2,365	2,398	2,432	2,466	2,501	2,536	2,572	2,608	2,645	2,682
		Dai Thanh	1.40%	2,120	2,150	2,180	2,211	2,242	2,273	2,305	2,337	2,370	2,403	2,437	2,471	2,506	2,541
		Van Phong	1.80%	1,710	1,741	1,772	1,804	1,836	1,869	1,903	1,937	1,972	2,007	2,043	2,080	2,117	2,155
		Total	1.50%	6,067	6,159	6,252	6,347	6,443	6,540	6,640	6,740	6,843	6,946	7,052	7,159	7,268	7,378
B-2	Gia Huynh	Village 1	1.13%	1,847	1,868	1,889	1,910	1,932	1,954	1,976	1,998	2,021	2,044	2,067	2,090	2,114	2,138
		Village 2	1.13%	1,734	1,754	1,774	1,794	1,814	1,834	1,855	1,876	1,897	1,918	1,940	1,962	1,984	2,006
		Village 3	1.13%	1,724	1,743	1,763	1,783	1,803	1,823	1,844	1,865	1,886	1,907	1,929	1,951	1,973	1,995
		Total	1.13%	5,305	5,365	5,426	5,487	5,549	5,611	5,675	5,739	5,804	5,869	5,936	6,003	6,071	6,139
B-3	Nghi Duc	Village 1	1.20%	1,441	1,458	1,475	1,493	1,511	1,529	1,547	1,566	1,585	1,604	1,623	1,642	1,662	1,682
		Village 2	0.90%	1,325	1,337	1,349	1,361	1,373	1,385	1,397	1,410	1,423	1,436	1,449	1,462	1,475	1,488
		Village 3	0.90%	1,291	1,303	1,315	1,327	1,339	1,351	1,363	1,375	1,387	1,399	1,412	1,425	1,438	1,451
		Village 4	1.00%	1,633	1,649	1,665	1,682	1,699	1,716	1,733	1,750	1,768	1,786	1,804	1,822	1,840	1,858
		Village 5	1.10%	1,605	1,623	1,641	1,659	1,677	1,695	1,714	1,733	1,752	1,771	1,790	1,810	1,830	1,850
		Village 6	1.20%	1,282	1,297	1,313	1,329	1,345	1,361	1,377	1,394	1,411	1,428	1,445	1,462	1,480	1,498
		Village 7	1.30%	1,726	1,748	1,771	1,794	1,817	1,841	1,865	1,889	1,914	1,939	1,964	1,990	2,016	2,042
		Total	1.10%	10,303	10,415	10,529	10,645	10,761	10,878	10,996	11,117	11,240	11,363	11,487	11,613	11,741	11,869
B-4	Tan Duc	Village 1	1.42%	767	778	789	800	811	823	835	847	859	871	883	896	909	922
		Village 2	1.42%	1,247	1,265	1,283	1,301	1,319	1,338	1,357	1,376	1,396	1,416	1,436	1,456	1,477	1,498
		Village 3	1.42%	1,751	1,776	1,801	1,827	1,853	1,879	1,906	1,933	1,960	1,988	2,016	2,045	2,074	2,103
		Village 4	1.42%	619	628	637	646	655	664	673	683	693	703	713	723	733	743
		Village 5	1.42%	668	677	687	697	707	717	727	737	747	758	769	780	791	802
		Total	1.42%	5,052	5,124	5,197	5,271	5,345	5,421	5,498	5,576	5,655	5,736	5,817	5,900	5,984	6,068
B-5	Me Pu	village 1	1.50%	2,159	2,191	2,224	2,257	2,291	2,325	2,360	2,395	2,431	2,467	2,504	2,542	2,580	2,619
		village 2	1.50%	1,391	1,412	1,433	1,454	1,476	1,498	1,520	1,543	1,566	1,589	1,613	1,637	1,662	1,687
		village 3	1.50%	1,822	1,849	1,877	1,905	1,934	1,963	1,992	2,022	2,052	2,083	2,114	2,146	2,178	2,211
		village 4	1.50%	1,973	2,003	2,033	2,063	2,094	2,125	2,157	2,189	2,222	2,255	2,289	2,323	2,358	2,393
		village 5	1.50%	1,917	1,946	1,975	2,005	2,035	2,066	2,097	2,128	2,160	2,192	2,225	2,258	2,292	2,326
		village 6	1.50%	825	837	850	863	876	889	902	916	930	944	958	972	987	1,002
		village 7	1.50%	192	195	198	201	204	207	210	213	216	219	222	225	228	231
		village 8	1.50%	2,746	2,787	2,829	2,871	2,914	2,958	3,002	3,047	3,093	3,139	3,186	3,234	3,283	3,332
		village 9	1.50%	424	430	436	443	450	457	464	471	478	485	492	499	506	514
		Total	1.50%	13,449	13,650	13,855	14,062	14,274	14,488	14,704	14,924	15,148	15,373	15,603	15,836	16,074	16,315
B-6	Sung Nhon	Village 1	1.30%	1,160	1,175	1,190	1,205	1,221	1,237	1,253	1,269	1,285	1,302	1,319	1,336	1,353	1,371
		Village 2	1.30%	1,607	1,628	1,649	1,670	1,692	1,714	1,736	1,759	1,782	1,805	1,828	1,852	1,876	1,900
		Village 3	1.30%	1,274	1,291	1,308	1,325	1,342	1,359	1,377	1,395	1,413	1,431	1,450	1,469	1,488	1,507
		Village 4	1.30%	1,312	1,329	1,346	1,363	1,381	1,399	1,417	1,435	1,454	1,473	1,492	1,511	1,531	1,551
		Village 5	1.30%	1,255	1,271	1,288	1,305	1,322	1,339	1,356	1,374	1,392	1,410	1,428	1,447	1,466	1,485
		Village 6	1.30%	841	852	863	874	885	897	909	921	933	945	957	969	982	995
		Village 7	1.30%	833	844	855	866	877	888	900	912	924	936	948	960	972	985
		Total	1.30%	8,282	8,390	8,499	8,608	8,720	8,833	8,948	9,065	9,183	9,302	9,422	9,544	9,668	9,794
B-7	Da Kai	Village 1	2.00%	1,190	1,214	1,238	1,263	1,288	1,314	1,340	1,367	1,394	1,422	1,450	1,479	1,509	1,539
		Village 2	2.50%	849	870	892	914	937	960	984	1,009	1,034	1,060	1,087	1,114	1,142	1,171
		Village 3	1.50%	1,114	1,131	1,148	1,165	1,182	1,200	1,218	1,236	1,255	1,274	1,293	1,312	1,332	1,352
		Village 4	2.70%	1,481	1,521	1,562	1,604	1,647	1,691	1,737	1,784	1,832	1,881	1,932	1,984	2,038	2,093
		Village 5	1.40%	1,715	1,739	1,763	1,788	1,813	1,838	1,864	1,890	1,916	1,943	1,970	1,998	2,026	2,054
		Village 6	0.60%	1,532	1,541	1,550	1,559	1,568	1,577	1,586	1,596	1,606	1,616	1,626	1,636	1,646	1,656
		Village 7	1.70%	1,335	1,358	1,381	1,404	1,428	1,452	1,477	1,502	1,528	1,554	1,580	1,607	1,634	1,662
		Village 8	1.00%	979	989	999	1,009	1,019	1,029	1,039	1,049	1,059	1,070	1,081	1,092	1,103	1,114
		Village 9	0.90%	976	985	994	1,003	1,012	1,021	1,030	1,039	1,048	1,057	1,067	1,077	1,087	1,097
		Village 10	1.30%	444	450	456	462	468	474	480	486	492	498	504	511	518	525
		Total	1.60%	11,615	11,798	11,983	12,171	12,362	12,556	12,755	12,958	13,164	13,375	13,590	13,810	14,035	14,263
Binh Thuan		Total	1.40%	60,073	60,901	61,741	62,591	63,454	64,327	65,216	66,119	67,037	67,964	68,907	69,865	70,841	71,826
TOTAL 4 provinces			1.60%	182,865	185,934	189,064	192,265	195,531	198,655	201,844	205,087	208,392	211,751	215,172	218,659	222,211	225,827

10.2 Water Demand

The results of calculation for water demand in the 24 communes are shown from next page.

The water used for the retail business in the rural area is classified as non-domestic water. Considering the feature of each commune, the rate of non-domestic water is classified into three, 5%, 10% and 13% by quartiles of actual data. The detailed result of the rate of domestic and non-domestic water uses in the Study area is shown in below.

Province/Commune			[1]	[2]	[3]	[4]	[5]	[6]	[7]
			Result of interview to CPC		Result of workshop in socio-economic servey		Result of calculation	Adopted percentage	Remark
			Domestic	Non-domestic	Domestic	Non-domestic	Non-domestic		
Phu Yen	P-1	Xuan Phuoc	95%	5%	89%	11%	12.4%	13%	
	P-2	An Dinh	96%	4%	95%	5%	5.3%	10%	The result of calculation for [5] is 5.3% and it is more than 5%, therefore this value is classified to 10%.
	P-3	An Tho	99%	1%	93%	8%	8.1%	10%	
	P-4	An My	65%	35%	89%	11%	11.9%	13%	
	P-5	Son Phuoc	85%	5%	90%	10%	11.6%	13%	
	P-6	Ea Cha Rang	96%	4%	92%	8%	8.7%	10%	
	P-7	Suoi Bac	92%	8%	88%	12%	13.6%	13%	
	P-8	Son Thanh Dong	96%	4%	-	-	-	5%	It is calculated based on the information of [2]
Khanh Hon	K-1	Cam An Bac	95%	5%	94%	6%	6.6%	10%	
	K-2	Com Hiep Nam	90%	10%	88%	12%	13.7%	13%	
	K-3	Cam Hai Tay	85%	15%	86%	14%	16.1%	13%	
Ninh Thuan	N-1	Nhon Hai	96%	4%	70%	30%	42.9%	13%	[5] is 43%, however, considering for [2], 13% is appropriate value.
	N-2	Cong hai	80%	20%	77%	23%	29.9%	13%	[2] and [5] are more than 20%, however, considering for feature of N-4 commune, it is similar with N-2 commune, therefore, 13% is appropriate value .
	N-3	Bac Son	96%	4%	-	-	-	13%	This commune is expected the economic growth.
	N-4	Phuoc Minh	85%	15%	-	-	-	13%	It is calculated based on the information of [2]
	N-5	Phuoc Hai	96%	4%	-	-	-	5%	It is calculated based on the information of [2]
	N-6	Phuoc Dinh	95%	5%	90%	10%	11.1%	13%	
Binh Thuan	B-1	Muong Man	95%	5%	90%	10%	11.1%	13%	
	B-2	Gia Huynh	95%	5%	89%	11%	12.0%	13%	
	B-3	Nghi Duc	96%	4%	94%	6%	6.8%	10%	
	B-4	Tan Duc	95%	5%	92%	8%	8.8%	10%	
	B-5	Me Pu	95%	5%	97%	3%	3.1%	5%	
	B-6	Sung Nhon	95%	5%	-	-	-	10%	It is calculated based on the information of [2]
	B-7	Da Kai	95%	5%	97%	3%	2.6%	5%	

*1: The result of calculation for rate of non-domestic water in case when rate of domestic water is 100%.

*2: Based on the results of quartiles of [5], rate of non-domestic water is classified into 3 categories, 5%, 10% and 13%.

Table 10.2.1 The Results of Calculation for Water Demand in the 24 Communes (1)

Province	Code	Commene	2007					2008					2009					2010				
			Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d)	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))
Phu Yen	P-1	Xuan Phuoc	9,182	551	72	69	692	9,305	558	73	70	701	9,430	566	74	71	711	9,557	573	74	72	719
	P-2	An Dinh	6,022	361	36	44	441	6,081	365	37	45	447	6,141	368	37	45	450	6,202	372	37	45	454
	P-3	An Tho	3,312	199	20	24	243	3,383	203	20	25	248	3,456	207	21	25	253	3,531	212	21	26	259
	P-4	An My	11,549	693	90	87	870	11,673	700	91	88	879	11,797	708	92	89	889	11,923	715	93	90	898
	P-5	Son Phuoc	3,313	199	26	25	250	3,366	202	26	25	253	3,419	205	27	26	258	3,473	208	27	26	261
	P-6	Ea Cha Rang	2,616	157	16	19	192	2,649	159	16	19	194	2,682	161	16	20	197	2,715	163	16	20	199
	P-7	Suoi Bac	5,678	341	44	43	428	5,730	344	45	43	432	5,783	347	45	44	436	5,837	350	46	44	440
	P-8	Son Thanh Don	8,309	499	25	58	582	8,379	503	25	59	587	8,450	507	25	59	591	8,524	511	26	60	597
Khanh Hoa	K-1	Cam An Bac	6,440	386	39	47	472	6,567	394	39	48	481	6,698	402	40	49	491	6,832	410	41	50	501
	K-2	Cam Hiep Nam	6,226	374	49	47	470	6,341	380	49	48	477	6,460	388	50	49	487	6,581	395	51	50	496
	K-3	Cam Hay Tay	5,825	350	46	44	440	5,907	354	46	44	444	5,989	359	47	45	451	6,073	364	47	46	457
Ninh Thuan	N-1	Nhon Hai	15,234	914	119	115	1,148	15,580	935	122	117	1,174	15,935	956	124	120	1,200	16,298	978	127	123	1,228
	N-2	Cong Hai	7,530	452	59	57	568	7,683	461	60	58	579	7,838	470	61	59	590	7,997	480	62	60	602
	N-3	Bac Son	5,922	355	46	45	446	6,038	362	47	45	454	6,156	369	48	46	463	6,277	377	49	47	473
	N-4	Phuoc Minh	3,596	216	28	27	271	3,684	221	29	28	278	3,775	227	30	29	286	3,868	232	30	29	291
	N-5	Phuoc Hai	13,126	788	39	92	919	13,377	803	40	94	937	13,631	818	41	95	954	13,892	834	42	97	973
	N-6	Phuoc Dinh	8,912	535	70	67	672	9,290	557	72	70	699	9,683	581	76	73	730	10,094	606	79	76	761
Binh Thuan	B-1	Muong Man	6,067	364	47	46	457	6,159	370	48	46	464	6,252	375	49	47	471	6,347	381	50	48	479
	B-2	Gia Huynh	5,305	318	41	40	399	5,365	322	42	40	404	5,426	326	42	41	409	5,487	329	43	41	413
	B-3	Nghi Duc	10,303	618	62	76	756	10,415	625	63	76	764	10,529	632	63	77	772	10,645	639	64	78	781
	B-4	Tan Duc	5,052	303	30	37	370	5,124	307	31	38	376	5,197	312	31	38	381	5,271	316	32	39	387
	B-5	Me Pu	13,449	807	40	94	941	13,650	819	41	96	956	13,855	831	42	97	970	14,062	844	42	98	984
	B-6	Suong Nhon	8,282	497	50	61	608	8,390	503	50	61	614	8,499	510	51	62	623	8,608	516	52	63	631
	B-7	Da Kai	11,615	697	35	81	813	11,798	708	35	83	826	11,983	719	36	84	839	12,171	730	37	85	852

Table 10.2.2 The Results of Calculation for Water Demand in the 24 Communes (2)

Province	Code	Commene	2011					2012					2013					2014				
			Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))
Phu Yen	P-1	Xuan Phuoc	9,685	581	76	73	730	9,816	589	77	74	740	9,949	597	78	75	750	10,083	605	79	76	760
	P-2	An Dinh	6,264	376	38	46	460	6,326	380	38	46	464	6,391	383	38	47	468	6,456	387	39	47	473
	P-3	An Tho	3,607	216	22	26	264	3,684	221	22	27	270	3,764	226	23	28	277	3,845	231	23	28	282
	P-4	An My	12,050	723	94	91	908	12,178	731	95	92	918	12,308	738	96	93	927	12,439	746	97	94	937
	P-5	Son Phuoc	3,529	212	28	27	267	3,585	215	28	27	270	3,643	219	28	27	274	3,702	222	29	28	279
	P-6	Ea Cha Rang	2,748	165	17	20	202	2,782	167	17	20	204	2,817	169	17	21	207	2,852	171	17	21	209
	P-7	Suoi Bac	5,891	353	46	44	443	5,946	357	46	45	448	6,002	360	47	45	452	6,058	363	47	46	456
	P-8	Son Thanh Don	8,598	516	26	60	602	8,674	520	26	61	607	8,750	525	26	61	612	8,826	530	27	62	619
Khanh Hoa	K-1	Cam An Bac	6,969	418	42	51	511	7,109	427	43	52	522	7,251	435	44	53	532	7,397	444	44	54	542
	K-2	Cam Hiep Nam	6,705	402	52	50	504	6,832	410	53	51	514	6,962	418	54	52	524	7,095	426	55	53	534
	K-3	Cam Hay Tay	6,158	369	48	46	463	6,245	375	49	47	471	6,332	380	49	48	477	6,420	385	50	48	483
Ninh Thuan	N-1	Nhon Hai	16,669	1,000	130	126	1,256	17,048	1,023	133	128	1,284	17,436	1,046	136	131	1,313	17,833	1,070	139	134	1,343
	N-2	Cong Hai	8,160	490	64	62	616	8,324	499	65	63	627	8,493	510	66	64	640	8,666	520	68	65	653
	N-3	Bac Son	6,399	384	50	48	482	6,523	391	51	49	491	6,650	399	52	50	501	6,779	407	53	51	511
	N-4	Phuoc Minh	3,963	238	31	30	299	4,061	244	32	31	307	4,161	250	33	31	314	4,263	256	33	32	321
	N-5	Phuoc Hai	14,159	850	43	99	992	14,430	866	43	101	1,010	14,706	882	44	103	1,029	14,988	899	45	105	1,049
	N-6	Phuoc Dinh	10,523	631	82	79	792	10,766	646	84	81	811	11,013	661	86	83	830	11,265	676	88	85	849
Binh Thuan	B-1	Muong Man	6,443	387	50	49	486	6,540	392	51	49	492	6,640	398	52	50	500	6,740	404	53	51	508
	B-2	Gia Huynh	5,549	333	43	42	418	5,611	337	44	42	423	5,675	341	44	43	428	5,739	344	45	43	432
	B-3	Nghi Duc	10,761	646	65	79	790	10,878	653	65	80	798	10,996	660	66	81	807	11,117	667	67	82	816
	B-4	Tan Duc	5,345	321	32	39	392	5,421	325	33	40	398	5,498	330	33	40	403	5,576	335	34	41	410
	B-5	Me Pu	14,274	856	43	100	999	14,488	869	43	101	1,013	14,704	882	44	103	1,029	14,924	895	45	104	1,044
	B-6	Suong Nhon	8,720	523	52	64	639	8,833	530	53	65	648	8,948	537	54	66	657	9,065	544	54	66	664
	B-7	Da Kai	12,362	742	37	87	866	12,556	753	38	88	879	12,755	765	38	89	892	12,958	777	39	91	907

Table 10.2.3 The Results of calculation for water demand in the 24 communes (3)

Province	Code	Commene	2015					2016				
			Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))
Phu Yen	P-1	Xuan Phuoc	10,219	613	80	77	770	10,356	621	81	78	780
	P-2	An Dinh	6,521	391	39	48	478	6,587	395	40	48	483
	P-3	An Tho	3,929	236	24	29	289	4,014	241	24	29	294
	P-4	An My	12,571	754	98	95	947	12,704	762	99	96	957
	P-5	Son Phuoc	3,761	226	29	28	283	3,821	229	30	29	288
	P-6	Ea Cha Rang	2,887	173	17	21	211	2,923	175	18	21	214
	P-7	Suoi Bac	6,115	367	48	46	461	6,173	370	48	46	464
	P-8	Son Thanh Don	8,902	534	27	62	623	8,979	539	27	63	629
Khanh Hoa	K-1	Cam An Bac	7,548	453	45	55	553	7,703	462	46	56	564
	K-2	Cam Hiep Nam	7,231	434	56	54	544	7,371	442	57	55	554
	K-3	Cam Hay Tay	6,510	391	51	49	491	6,601	396	51	50	497
Ninh Thuan	N-1	Nhon Hai	18,239	1,094	142	137	1,373	18,655	1,119	145	140	1,404
	N-2	Cong Hai	8,843	531	69	67	667	9,021	541	70	68	679
	N-3	Bac Son	6,911	415	54	52	521	7,045	423	55	53	531
	N-4	Phuoc Minh	4,368	262	34	33	329	4,475	269	35	34	338
	N-5	Phuoc Hai	15,275	917	46	107	1,070	15,569	934	47	109	1,090
	N-6	Phuoc Dinh	11,525	692	90	87	869	11,790	707	92	89	888
Binh Thuan	B-1	Muong Man	6,843	411	53	52	516	6,946	417	54	52	523
	B-2	Gia Huynh	5,804	348	45	44	437	5,869	352	46	44	442
	B-3	Nghi Duc	11,240	674	67	82	823	11,363	682	68	83	833
	B-4	Tan Duc	5,655	339	34	41	414	5,736	344	34	42	420
	B-5	Me Pu	15,148	909	45	106	1,060	15,373	922	46	108	1,076
	B-6	Suong Nhon	9,183	551	55	67	673	9,302	558	56	68	682
	B-7	Da Kai	13,164	790	40	92	922	13,375	803	40	94	937

Province	Code	Commene	2017					2018				
			Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))
Phu Yen	P-1	Xuan Phuoc	10,495	630	82	79	791	10,637	638	83	80	801
	P-2	An Dinh	6,654	399	40	49	488	6,721	403	40	49	492
	P-3	An Tho	4,101	246	25	30	301	4,189	251	25	31	307
	P-4	An My	12,840	770	100	97	967	12,977	779	101	98	978
	P-5	Son Phuoc	3,882	233	30	29	292	3,945	237	31	30	298
	P-6	Ea Cha Rang	2,959	178	18	22	218	2,996	180	18	22	220
	P-7	Suoi Bac	6,232	374	49	47	470	6,291	377	49	47	473
	P-8	Son Thanh Don	9,056	543	27	63	633	9,133	548	27	64	639
Khanh Hoa	K-1	Cam An Bac	7,861	472	47	58	577	8,022	481	48	59	588
	K-2	Cam Hiep Nam	7,513	451	59	57	567	7,659	460	60	58	578
	K-3	Cam Hay Tay	6,693	402	52	50	504	6,787	407	53	51	511
Ninh Thuan	N-1	Nhon Hai	19,079	1,145	149	144	1,438	19,514	1,171	152	147	1,470
	N-2	Cong Hai	9,203	552	72	69	693	9,390	563	73	71	707
	N-3	Bac Son	7,182	431	56	54	541	7,322	439	57	55	551
	N-4	Phuoc Minh	4,585	275	36	35	346	4,699	282	37	35	354
	N-5	Phuoc Hai	15,869	952	48	111	1,111	16,174	970	49	113	1,132
	N-6	Phuoc Dinh	12,061	724	94	91	909	12,339	740	96	93	929
Binh Thuan	B-1	Muong Man	7,052	423	55	53	531	7,159	430	56	54	540
	B-2	Gia Huynh	5,936	356	46	45	447	6,003	360	47	45	452
	B-3	Nghi Duc	11,487	689	69	84	842	11,613	697	70	85	852
	B-4	Tan Duc	5,817	349	35	43	427	5,900	354	35	43	432
	B-5	Me Pu	15,603	936	47	109	1,092	15,836	950	48	111	1,109
	B-6	Suong Nhon	9,422	565	57	69	691	9,544	573	57	70	700
	B-7	Da Kai	13,590	815	41	95	951	13,810	829	41	97	967

Table 10.2.4 The Results of Calculation for Water Demand in the 24 Communes (4)

Province	Code	Commene	2019					2020				
			Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))	Popiulation (Persons)	Domestic (m3/d)	Non-domestic (m3/d)	Leakage (10%,m3/d)	Total (m3/d))
Phu Yen	P-1	Xuan Phuoc	10,781	647	84	81	812	10,927	656	85	82	823
	P-2	An Dinh	6,788	407	41	50	498	6,856	411	41	50	502
	P-3	An Tho	4,280	257	26	31	314	4,373	262	26	32	320
	P-4	An My	13,115	787	102	99	988	13,256	795	103	100	998
	P-5	Son Phuoc	4,008	240	31	30	301	4,071	244	32	31	307
	P-6	Ea Cha Rang	3,033	182	18	22	222	3,072	184	18	22	224
	P-7	Suoi Bac	6,351	381	50	48	479	6,411	385	50	48	483
	P-8	Son Thanh Don	9,212	553	28	65	646	9,292	558	28	65	651
Khanh Hoa	K-1	Cam An Bac	8,186	491	49	60	600	8,355	501	50	61	612
	K-2	Cam Hiep Nam	7,809	469	61	59	589	7,962	478	62	60	600
	K-3	Cam Hay Tay	6,882	413	54	52	519	6,978	419	54	53	526
Ninh Thuan	N-1	Nhon Hai	19,958	1,197	156	150	1,503	20,413	1,225	159	154	1,538
	N-2	Cong Hai	9,581	575	75	72	722	9,776	587	76	74	737
	N-3	Bac Son	7,464	448	58	56	562	7,609	457	59	57	573
	N-4	Phuoc Minh	4,815	289	38	36	363	4,934	296	38	37	371
	N-5	Phuoc Hai	16,485	989	49	115	1,153	16,804	1,008	50	118	1,176
	N-6	Phuoc Dinh	12,622	757	98	95	950	12,911	775	101	97	973
Binh Thuan	B-1	Muong Man	7,268	436	57	55	548	7,378	443	58	56	557
	B-2	Gia Huynh	6,071	364	47	46	457	6,139	368	48	46	462
	B-3	Nghi Duc	11,741	704	70	86	860	11,869	712	71	87	870
	B-4	Tan Duc	5,984	359	36	44	439	6,068	364	36	44	444
	B-5	Me Pu	16,074	964	48	112	1,124	16,315	979	49	114	1,142
	B-6	Suong Nhon	9,668	580	58	71	709	9,794	588	59	72	719
	B-7	Da Kai	14,035	842	42	98	982	14,263	856	43	100	999

10.3 Deducted Water Demand

The population supplied by existing water system is deducted from total water demand in the commune. The deducted water demand from 2006 to 2020 is shown in the below. The results of calculation for water demand in the 22 communes are shown from next page.

Table 10.3.1 The Deducted Water Demand from 2006 to 2020

Code	Commune	2006	2007	2012	2017	2020
P-1	Xuan Phuoc	683	692	740	791	823
P-2	An Dinh	438	441	464	488	502
P-4	An My	861	870	918	967	998
P-5	Son Phuoc	187	190	206	223	234
P-6	Ea Cha Rang	133	135	143	153	157
P-7	Suoi Bac	424	428	448	470	483
P-8	Son Thanh Don	577	582	607	633	651
K-1	Cam An Bac	367	374	414	458	485
K-2	Cam Hiep Nam	461	470	514	567	600
K-3	Cam Hay Tay	800	440	471	504	526
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	120	122	134	148	156
N-5	Phuoc Hai	902	919	1,010	1,111	1,176
N-6	Phuoc Dinh	644	672	811	909	973
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	343	347	373	400	416
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		12,542	12,372	13,417	14,507	15,204

Table 10.3.2 The Result of Calculation for the Deducted Water Demand in 22 Communes (1)

Province	Code	Commune	Percentage of deduction (%)	2007			2008			2009			2010			2011		
				Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)
Phu Yen	P-1	Xuan Phuoc	0%	692	0	692	701	0	701	711	0	711	719	0	719	730	0	730
	P-2	An Dinh	0%	441	0	441	447	0	447	450	0	450	454	0	454	460	0	460
	P-4	An My	0%	870	0	870	879	0	879	889	0	889	898	0	898	908	0	908
	P-5	Son Phuoc	24%	250	-60	190	253	-60	193	258	-61	197	261	-62	199	267	-64	203
	P-6	Ea Cha Rang	30%	192	-57	135	194	-58	136	197	-59	138	199	-60	139	202	-60	142
	P-7	Suoi Bac	0%	428	0	428	432	0	432	436	0	436	440	0	440	443	0	443
	P-8	Son Thanh Don	0%	582	0	582	587	0	587	591	0	591	597	0	597	602	0	602
Khanh Hoa	K-1	Cam An Bac	21%	472	-98	374	481	-100	381	491	-102	389	501	-104	397	511	-106	405
	K-2	Cam Hiep Nam	0%	470	0	470	477	0	477	487	0	487	496	0	496	504	0	504
	K-3	Cam Hay Tay	0%	440	0	440	444	0	444	451	0	451	457	0	457	463	0	463
Ninh Thuan	N-1	Nhon Hai	0%	1,148	0	1,148	1,174	0	1,174	1,200	0	1,200	1,228	0	1,228	1,256	0	1,256
	N-2	Cong Hai	0%	568	0	568	579	0	579	590	0	590	602	0	602	616	0	616
	N-3	Bac Son	73%	446	-324	122	454	-330	124	463	-337	126	473	-344	129	482	-350	132
	N-5	Phuoc Hai	0%	919	0	919	937	0	937	954	0	954	973	0	973	992	0	992
	N-6	Phuoc Dinh	0%	672	0	672	699	0	699	730	0	730	761	0	761	792	0	792
Binh Thuan	B-1	Muong Man	0%	457	0	457	464	0	464	471	0	471	479	0	479	486	0	486
	B-2	Gia Huynh	0%	399	0	399	404	0	404	409	0	409	413	0	413	418	0	418
	B-3	Nghi Duc	0%	756	0	756	764	0	764	772	0	772	781	0	781	790	0	790
	B-4	Tan Duc	6%	370	-23	347	376	-24	352	381	-24	357	387	-24	363	392	-25	367
	B-5	Me Pu	0%	941	0	941	956	0	956	970	0	970	984	0	984	999	0	999
	B-6	Suong Nhon	0%	608	0	608	614	0	614	623	0	623	631	0	631	639	0	639
	B-7	Da Kai	0%	813	0	813	826	0	826	839	0	839	852	0	852	866	0	866

Table 10.3.3 The Result of Calculation for the Deducted Water Demand in 22 Communes (2)

Province	Code	Commune	Percentage of deduction (%)	2012			2013			2014			2015			2016		
				Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)
Phu Yen	P-1	Xuan Phuoc	0%	740	0	740	750	0	750	760	0	760	770	0	770	780	0	780
	P-2	An Dinh	0%	464	0	464	468	0	468	473	0	473	478	0	478	483	0	483
	P-4	An My	0%	918	0	918	927	0	927	937	0	937	947	0	947	957	0	957
	P-5	Son Phuoc	24%	270	-64	206	274	-65	209	279	-66	213	283	-67	216	288	-69	219
	P-6	Ea Cha Rang	30%	204	-61	143	207	-62	145	209	-62	147	211	-63	148	214	-64	150
	P-7	Suoi Bac	0%	448	0	448	452	0	452	456	0	456	461	0	461	464	0	464
	P-8	Son Thanh Don	0%	607	0	607	612	0	612	619	0	619	623	0	623	629	0	629
Khanh Hoa	K-1	Cam An Bac	21%	522	-108	414	532	-110	422	542	-112	430	553	-114	439	564	-117	447
	K-2	Cam Hiep Nam	0%	514	0	514	524	0	524	534	0	534	544	0	544	554	0	554
	K-3	Cam Hay Tay	0%	471	0	471	477	0	477	483	0	483	491	0	491	497	0	497
Ninh Thuan	N-1	Nhon Hai	0%	1,284	0	1,284	1,313	0	1,313	1,343	0	1,343	1,373	0	1,373	1,404	0	1,404
	N-2	Cong Hai	0%	627	0	627	640	0	640	653	0	653	667	0	667	679	0	679
	N-3	Bac Son	73%	491	-357	134	501	-364	137	511	-371	140	521	-379	142	531	-386	145
	N-5	Phuoc Hai	0%	1,010	0	1,010	1,029	0	1,029	1,049	0	1,049	1,070	0	1,070	1,090	0	1,090
	N-6	Phuoc Dinh	0%	811	0	811	830	0	830	849	0	849	869	0	869	888	0	888
Binh Thuan	B-1	Muong Man	0%	492	0	492	500	0	500	508	0	508	516	0	516	523	0	523
	B-2	Gia Huynh	0%	423	0	423	428	0	428	432	0	432	437	0	437	442	0	442
	B-3	Nghi Duc	0%	798	0	798	807	0	807	816	0	816	823	0	823	833	0	833
	B-4	Tan Duc	6%	398	-25	373	403	-25	378	410	-26	384	414	-26	388	420	-26	394
	B-5	Me Pu	0%	1,013	0	1,013	1,029	0	1,029	1,044	0	1,044	1,060	0	1,060	1,076	0	1,076
	B-6	Suong Nhon	0%	648	0	648	657	0	657	664	0	664	673	0	673	682	0	682
	B-7	Da Kai	0%	879	0	879	892	0	892	907	0	907	922	0	922	937	0	937

Table 10.3.4 The Result of Calculation for the Deducted Water Demand in 22 Communes (3)

Province	Code	Commune	Percentage of deduction (%)	2017			2018			2019			2020		
				Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)	Water demand	Existing water supply	Total (m3/d)
Phu Yen	P-1	Xuan Phuoc	0%	791	0	791	801	0	801	812	0	812	823	0	823
	P-2	An Dinh	0%	488	0	488	492	0	492	498	0	498	502	0	502
	P-4	An My	0%	967	0	967	978	0	978	988	0	988	998	0	998
	P-5	Son Phuoc	24%	292	-69	223	298	-71	227	301	-72	229	307	-73	234
	P-6	Ea Cha Rang	30%	218	-65	153	220	-66	154	222	-66	156	224	-67	157
	P-7	Suoi Bac	0%	470	0	470	473	0	473	479	0	479	483	0	483
	P-8	Son Thanh Don	0%	633	0	633	639	0	639	646	0	646	651	0	651
Khanh Hoa	K-1	Cam An Bac	21%	577	-119	458	588	-122	466	600	-124	476	612	-127	485
	K-2	Cam Hiep Nam	0%	567	0	567	578	0	578	589	0	589	600	0	600
	K-3	Cam Hay Tay	0%	504	0	504	511	0	511	519	0	519	526	0	526
Ninh Thuan	N-1	Nhon Hai	0%	1,438	0	1,438	1,470	0	1,470	1,503	0	1,503	1,538	0	1,538
	N-2	Cong Hai	0%	693	0	693	707	0	707	722	0	722	737	0	737
	N-3	Bac Son	73%	541	-393	148	551	-401	150	562	-409	153	573	-417	156
	N-5	Phuoc Hai	0%	1,111	0	1,111	1,132	0	1,132	1,153	0	1,153	1,176	0	1,176
	N-6	Phuoc Dinh	0%	909	0	909	929	0	929	950	0	950	973	0	973
Binh Thuan	B-1	Muong Man	0%	531	0	531	540	0	540	548	0	548	557	0	557
	B-2	Gia Huynh	0%	447	0	447	452	0	452	457	0	457	462	0	462
	B-3	Nghi Duc	0%	842	0	842	852	0	852	860	0	860	870	0	870
	B-4	Tan Duc	6%	427	-27	400	432	-27	405	439	-28	411	444	-28	416
	B-5	Me Pu	0%	1,092	0	1,092	1,109	0	1,109	1,124	0	1,124	1,142	0	1,142
	B-6	Suong Nhon	0%	691	0	691	700	0	700	709	0	709	719	0	719
	B-7	Da Kai	0%	951	0	951	967	0	967	982	0	982	999	0	999

10.4 Design Capacity

The results of calculation for design capacity in the 22 communes are shown from next page.

Table 10.4.1 The Results of Calculation for Design Capacity in 22 Communes from 2006 to 2020 (1)

Province	Code	Commune	2006			2007			2012		
			Daily Average Supply (m3/d)	Daily Maximum Supply (m3/d)	Hourly Maximum Supply (m3/hr)	Daily Average Supply (m3/d)	Daily Maximum Supply (m3/d)	Hourly Maximum Supply (m3/hr)	Daily Average Supply (m3/d)	Daily Maximum Supply (m3/d)	Hourly Maximum Supply (m3/hr)
Phu Yen	P-1	Xuan Phuoc	683	820	68.3	692	830	69.2	740	888	74.0
	P-2	An Dinh	438	526	43.8	441	529	44.1	464	557	46.4
	P-4	An My	861	1033	86.1	870	1044	87.0	918	1102	91.8
	P-5	Son Phuoc	187	224	18.7	190	228	19.0	206	247	20.6
	P-6	Ea Cha Rang	133	160	13.3	135	162	13.5	143	172	14.3
	P-7	Suoi Bac	424	509	42.4	428	514	42.8	448	538	44.8
	P-8	Son Thanh Don	577	692	57.7	582	698	58.2	607	728	60.7
	Sub-total		3,303	3,964		3,338	4,005		3,526	4,232	
Khanh Hoa	K-1	Cam An Bac	367	440	36.7	374	449	37.4	414	497	41.4
	K-2	Cam Hiep Nam	461	553	46.1	470	564	47.0	514	617	51.4
	K-3	Cam Hay Tay	800	960	80.0	440	528	44.0	471	565	47.1
	Sub-total		1,628	1,953		1,284	1,541		1,399	1,679	
Ninh Thuan	N-1	Nhon Hai	1,122	1346	112.2	1,148	1378	114.8	1,284	1541	128.4
	N-2	Cong Hai	557	668	55.7	568	682	56.8	627	752	62.7
	N-3	Bac Son	120	144	12.0	122	146	12.2	134	161	13.4
	N-5	Phuoc Hai	902	1082	90.2	919	1103	91.9	1,010	1212	101.0
	N-6	Phuoc Dinh	644	773	64.4	672	806	67.2	811	973	81.1
	Sub-total		3,345	4,013		3,429	4,115		3,866	4,639	
Binh Thuan	B-1	Muong Man	451	541	45.1	457	548	45.7	492	590	49.2
	B-2	Gia Huynh	396	475	39.6	399	479	39.9	423	508	42.3
	B-3	Nghi Duc	748	898	74.8	756	907	75.6	798	958	79.8
	B-4	Tan Duc	343	412	34.3	347	416	34.7	373	448	37.3
	B-5	Me Pu	928	1114	92.8	941	1129	94.1	1,013	1216	101.3
	B-6	Suong Nhon	600	720	60.0	608	730	60.8	648	778	64.8
	B-7	Da Kai	800	960	80.0	813	976	81.3	879	1055	87.9
	Sub-total		4,266	5,120		4,321	5,185		4,626	5,553	
Total			12,542	15,050		12,372	14,846		13,417	16,103	

Table 10.4.2 The Results of Calculation for Design Capacity in 22 Communes from 2006 to 2020 (2)

Province	Code	Commune	2017			2020		
			Daily Average Supply (m3/d)	Daily Maximum Supply (m3/d)	Hourly Maximum Supply (m3/hr)	Daily Average Supply (m3/d)	Daily Maximum Supply (m3/d)	Hourly Maximum Supply (m3/hr)
Phu Yen	P-1	Xuan Phuoc	791	949	79.1	823	988	82.3
	P-2	An Dinh	488	586	48.8	502	602	50.2
	P-4	An My	967	1160	96.7	998	1198	99.8
	P-5	Son Phuoc	223	268	22.3	234	281	23.4
	P-6	Ea Cha Rang	153	184	15.3	157	188	15.7
	P-7	Suoi Bac	470	564	47.0	483	580	48.3
	P-8	Son Thanh Don	633	760	63.3	651	781	65.1
	Sub-total		3,725	4,471		3,848	4,618	
Khanh Hoa	K-1	Cam An Bac	458	550	45.8	485	582	48.5
	K-2	Cam Hiep Nam	567	680	56.7	600	720	60.0
	K-3	Cam Hay Tay	504	605	50.4	526	631	52.6
	Sub-total		1,529	1,835		1,611	1,933	
Ninh Thuan	N-1	Nhon Hai	1,438	1726	143.8	1,538	1846	153.8
	N-2	Cong Hai	693	832	69.3	737	884	73.7
	N-3	Bac Son	148	178	14.8	156	187	15.6
	N-5	Phuoc Hai	1,111	1333	111.1	1,176	1411	117.6
	N-6	Phuoc Dinh	909	1091	90.9	973	1168	97.3
	Sub-total		4,299	5,160		4,580	5,496	
Binh Thuan	B-1	Muong Man	531	637	53.1	557	668	55.7
	B-2	Gia Huynh	447	536	44.7	462	554	46.2
	B-3	Nghi Duc	842	1010	84.2	870	1044	87.0
	B-4	Tan Duc	400	480	40.0	416	499	41.6
	B-5	Me Pu	1,092	1310	109.2	1,142	1370	114.2
	B-6	Suong Nhon	691	829	69.1	719	863	71.9
	B-7	Da Kai	951	1141	95.1	999	1199	99.9
	Sub-total		4,954	5,943		5,165	6,197	
Total			14,507	17,409		15,204	18,244	

CHAPTER 11

DESIGN WATER SUPPLY SYSTEM

CHAPTER 11 DESIGN WATER SUPPLY SYSTEM

11.1 Basic Conditions for Water Supply System

The basic conditions for water supply system are shown in the following page.

Table 11.1.1 Basic Design Conditions for Water Supply System

System	Facility No.	Commune	Population in 2020	Design flow (m3/d)	Intake flow (m3/d)	Structure of intake	Design conditions for intake facility and transmission pipe					Necessity of treatment
							Transmission interval (km)	Design interval (km)	Intake GL－Service area GL=vertical drop (m)	Necessity of high lift pump	Necessity of special structure	
Single	FPS-1	P-1	10,927	980	1,080	River intake	13	20	10			×
Single	FPS-2	P-2	6,859	600	660	Pipe connection of dam outlet	5	8	15			×
Single	FPS-3	P-4	13,256	1190	1,190	Well	0	0	0			
Group	FPG-4	P-5 P-6 P-7	12,136	1080	1,190	River intake	4	6	-120	×	Road crossing (No.25)	×
Single	FPS-5	P-8	9,292	770	770	Well	0	0	0			
Single	FKS-6	K-1	6,462	560	560	Well	0	0	0			×
Single	FKW-7	K-2	7,962	710	780	Reservoir	16	24	0			×
Single	FKS-8	K-3	12,840	403+747=1150 1150	403+822=1,225 1230	Irrigation channel	1+4=5 5	8	-10		Road crossing (No.1)	×
Group	FNW-9	N-1 N-2 N-3	34,850	3,120	3,430	Surface water	15	23	0		Road crossing (No.1) Rail way crossing	×
Wide	FNG-10	N-5 N-6	34,649	3,000	3,300	Surface water	8	12	0		Road crossing (No.1) Rail way crossing	×
Single	FBS-11	B-1	7,378	660	730	Surface water	5	8	10			×
Wide	FBW-12	B-2 B-4	12,207	1,080	1,190	Surface water	16	24	20			×
Group	FBG-13	B-3 B-5 B-6 B-7	52,241	4,430	4,880	Surface water	4	6	-20			×

CHAPTER 12

ORGANIZATIONAL PROFILES OF P-CERWASS

CHAPTER 12 ORGANIZATIONAL PROFILES OF P-CERWASS

12.1 Introduction

P-CERWASS is an implementing authority of rural water supply and sanitation at provincial level, which belongs to DARD. Major roles of P-CERWASS are water supply project planning, facility designing, construction supervision, establishing O&M organization, staff training, IEC activities, etc. Not a small number of P-CERWASS carry out O&M of facilities, depending on policy of province.

Four P-CERWASS of the study areas are assessed to profile the management organization and activities. The information is based on field survey in July 2007.

12.2 Profiles of P-CERWASS

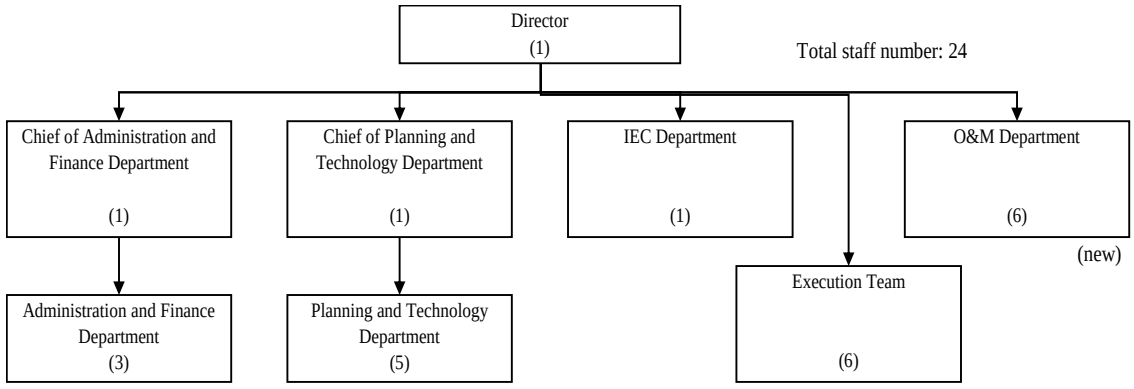
12.2.1 Phu Yen P-CERWASS

(1) Roles of P-CERWASS

P-CERWASS Phu Yen is responsible for project planning, facility designing, construction supervision, establishing O&M organization, staff training, IEC activities. To date the P-CERWASS don't carry out O&M of facilities. However, in the course of the Study, O&M structure was proposed by the Study Team, which is to be managed directly under the P-CERWASS. And P-CERWASS is mandated by DARD and PPC as an O&M entity for newly constructed water supply facility. In this regard, O&M department was newly established and embarked on O&M at Xuan Tho Commune.

(2) Organization Chart

Phu Yen P-CERWASS was established in 1992. As of October 2008, 24 staff is engaged in Phu Yen P-CERWASS. In general, every staff has high loyalty to the organization.



Source: Phu Yen P-CERWASS, July 2007 and October 2008, modified by Study Team

Figure 12.2.1 Organization Chart of Phu Yen P-CERWASS

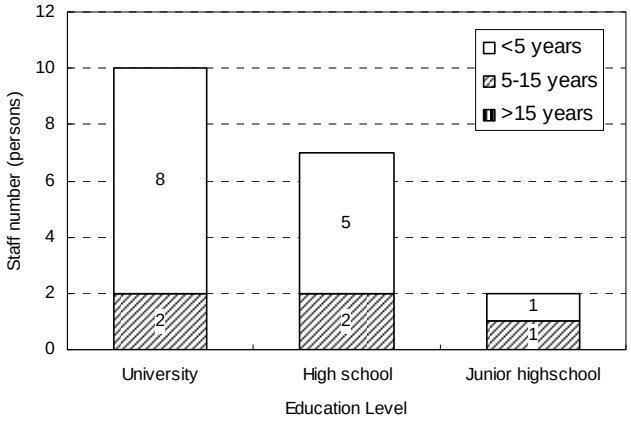
Table 12.2.1 Main Duties by Section

Department	Duty
Administration and Finance	Personnel affairs General managerial affairs Coordination with the union about working conditions, etc.
Planning and Technology	Coordination with the administration and finance department to prepare and implement the government's resolution Preparation of annual plan and activity report
Communication	IEC activity
Execution team	Construction work under P-CERWASS execution plan Management and control of workers in drilling wells Selection of drilling points and aquifer, etc. Water quality check Building biogas cesspool, hygienic latrines
O&M	O&M of water supply facility (As a trial case, so far they are engaged in Xuan Tho Commune)

Source: Information from Phu Yen P-CERWASS, October 2008

(3) Education Level and Working Experience

There are 24 staff engaged, out of which 10 are university graduates and 7 are high school graduates. Most staff has working experience under 5 years, which implies insufficient technological level. Since it seems difficult to provide sufficient training to staff among the current organization, external training resources should be utilized, such as urban water corporation, etc. In this regard, capacity development plan is described in the main report.



(Note) There is a contradiction in staff number between the organization chart and this chart, although both are provided by P-CERWASS.
Source: Information from Phu Yen P-CERWASS, July 2007

Figure 12.2.2 Number of Staff by Education Level and Work Experience

(4) Staff Training

Staff training is mainly performed through on-the-job training. No particular training course is provided by P-CERWASS to staff. Office staffs occasionally attend the training course organized by C-CERWASS. Training for executive officers are seldom provided.

P-CERWASS realizes necessity of training in the fields of hydraulic engineering, geological

engineering, water supply planning, technical workmanship and O&M skill. In this connection, technical seminar was organized in 2008 with 61 participants by inviting lectures from the urban water cooperation and the construction technical college No.3.

(5) Financial Status

P-CERWASS is financially dependent on central and/or provincial budget. According to information from P-CERWASS, investment cost is borne by the central government and budget for annual activity is provided by the provincial government. The budget for Phu Yen P-CERWASS is shown in Table below:

Table 12.2.2 Budgetaty Trend for Phu Yen P-CERWASS

(Unit: million VND)

Year	Total Amount	Budget by fund source				
		Central Gov't	Donor Agency	Provincial Gov't	District Gov't	From business (water sales)
2005	198	-	-	198	-	-
2006	198	-	-	198	-	-
2007	198	-	-	198	-	-

Source: Information from Phu Yen P-CERWASS, July 2007

(6) Physical Assets

P-CERWASS owns buildings, vehicles and machineries as shown in table.

Table 12.2.3 Major Assets owned by P-CERWASS

Item	Quantity
1. Administration Building	1 Building
2. Vehicles and Machinery	1 Pickup 1 Drilling rig 2 Motorbikes (Old condition)

Source: Information from Phu Yen P-CERWASS, July 2007

(7) IEC activity

IEC is performed by the communication department of P-CERWASS.

(8) Document and Information Management

Document is managed in conventional way; stored in cabinet only. Information management and sharing seem to be on insufficient level.

(9) Prospect of organizational capacity

Although Phu Yen P-CERWASS hasn't experienced in O&M of water supply facilities, it has provided technical assistance to establish O&M organization in local level and training for operators. Recent effort by the DARD and P-CERWASS should be appreciated that they recognizes necessity of staff training on O&M in response to new management policy of P-CERWASS, under which new

water supply facilities are to be managed under P-CERWASS, and that technical training begun by using external training resources, such as the urban water corporation and construction technical college No.3. Also Phu Yen P-CERWASS is receiving technical assistance from Binh Thuan P-CERWASS which is successfully managed and capable to provide sufficient technical training.

Since there is a strong leadership of PPC Phu Yen, coordination among related organizations seems done well. In this sense, the P-CERWASS has good potential to learn sufficient knowledge and skill through external training resources for a few years ahead when the proposed project in the Study would be completed.

12.2.2 Khanh Hoa P-CERWASS

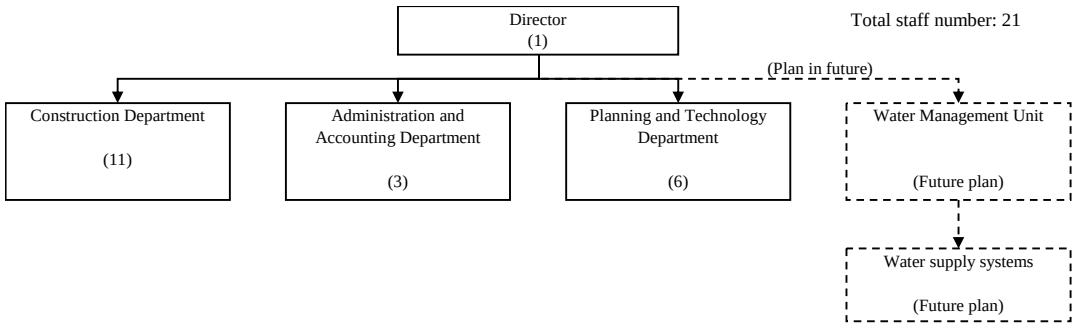
(1) Roles of P-CERWASS

P-CERWASS Khanh Hoa has the same organizational background and roles as the Phu Yen P-CERWASS. To date the P-CERWASS don't carry out O&M of facilities. However, as proposed by the Study Team, the P-CERWASS is also mandated by DARD and PPC as an O&M entity for newly constructed water supply facility. In this regard, P-CERWASS has a plan to establish water management unit under P-CERWASS for O&M of the new water supply facilities.

(2) Organization Chart

Khanh Hoa P-CERWASS was established in 1996. As of July 2007, 21 staff is engaged in the P-CERWASS. To date there is no department so that each staff work under instruction by director of P-CERWASS. There will be establishment of two departments in near future; administration and accounting department and planning and technology department.

Currently P-CERWASS has no water supply activity but plans to own and operate piped water supply systems in future when new water supply system will be build in any commune.



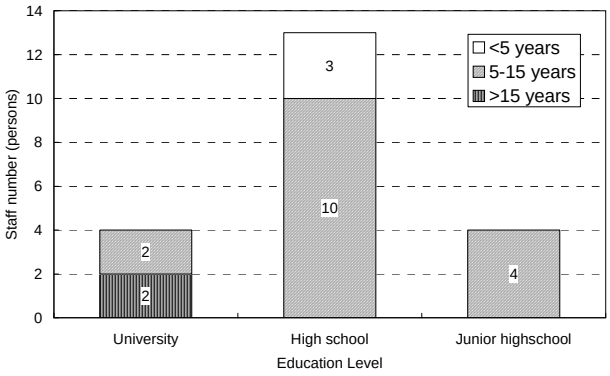
(Note)
As of July 2007, there is no department.
Two departments will be established as the above chart.
Khanh Hoa P-CERWASS plans to establish water management unit in future in order to O&M of the water supply facility.

Source: Khanh Hoa P-CERWASS, July 2007

Figure 12.2.3 Organization Chart of Khanh Hoa P-CERWASS

(3) Education Level and Working Experience

Number of staff having more than 15 years experience is only two while most staff have experience of 5-15 years. Number of university graduate employees is four which seems relatively small considering broad tasks, such as planning and management.



Source: Information from Khanh Hoa P-CERWASS, July 2007

Figure 12.2.4 Number of Staff by Education Level and Work Experience

(4) Staff Training

Staff training is mainly performed through on-the-job training. No particular training course is provided by P-CERWASS to staff. Office staffs occasionally attend the training course organized by C-CERWASS.

P-CERWASS realizes necessity of training in every field of engineering, financial and management.

(5) Financial Status

P-CERWASS is financially dependent mainly on central and/or provincial budget. According to information from P-CERWASS, investment cost is borne by the central government and budget for annual activity is also provided by the central government. In the past the P-CERWASS received some budget support from donor agencies. The budget for the P-CERWASS is shown in Table below:

Table 12.2.4 Budgetaty Trend for Khanh Hoa P-CERWASS

(Unit: million VND)

Year	Total Amount	Budget by fund source				
		Central Gov't	Donor Agency	Provincial Gov't	District Gov't	From business (water sales)
2005	250	200	50	-	-	-
2006	217	200	17	-	-	-
2007	200	200	-	-	-	-

Source: Information from Khanh Hoa P-CERWASS, July 2007

(6) Physical Assets

Physical assets owned by P-CERWASS are summarized in Table.

Table 12.2.5 Major Assets owned by P-CERWASS

Item	Quantity
1. Administration Building	1 Building
2. Vehicles and Machinery	1 Pickup truck 1 Sedan 3 Motorbikes 2 Drilling rigs (old Chinese rigs)
3. Water quality test kit	No

Source: Information from Khanh Hoa P-CERWASS, July 2007

(7) IEC activity

IEC for sanitation improvement is one of responsibility of P-CERWASS. P-CERWASS receives subsidy for IEC from PPC. No particular department is in charge of IEC. P-CEWASS recently proposed to PPC that loan conditions of government support for building dug well and toilet will be extended from currently 3 years to 10 years in order to attract more people to apply.

(8) Prospect of organizational capacity

As discussed in the above sub-section of Phu Yen P-CERWASS, Khanh Hoa P-CERWASS hasn't experienced in O&M of water supply facilities, it has provided technical assistance to establish O&M organization in local level and training for operators. Khan Hoa P-CERWASS is to receive technical assistance from Ninh Thuan P-CERWASS which is in the adjacent province and experienced in O&M for years.

Since involvement of the provincial organization, namely DARD, seems still low, progress of developing O&M capacity is behind that of Phu Yen. However, Khanh Hoa P-CERWASS keeps discussion with DARD to reform the organization in order to perform O&M of new facilities. Hence, progress of reforming organizational structure and necessary capacity development should be monitored in the project implementation phase.

12.2.3 Ninh Thuan P-CERWASS

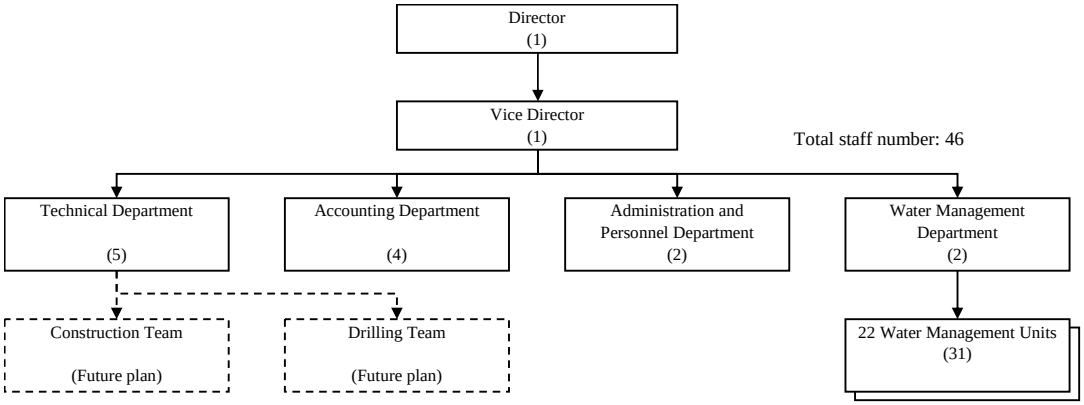
(1) Roles of P-CERWASS

Unlike the aforementioned P-CERWASS, Ninh Thuan P-CERWASS provides O&M of water supply facilities, in addition to the project planning, designing and construction supervision.

Although Ninh Thuan P-CERWASS is the mandate authority of RWSS in the province, there exist 20 water supply systems managed by DPC or Commune, since they were constructed before establishment of the P-CERWASS. These facilities are discussed to be merged into management of P-CERWASS. However, these systems are currently managed as a part of public service, including garbage collection, public market, etc. Therefore, it is said difficult to transfer soon.

(2) Organization Chart

Ninh Thuan P-CERWASS was established in 1999. As of July 2007, 46 staff are engaged in the P-CERWASS.



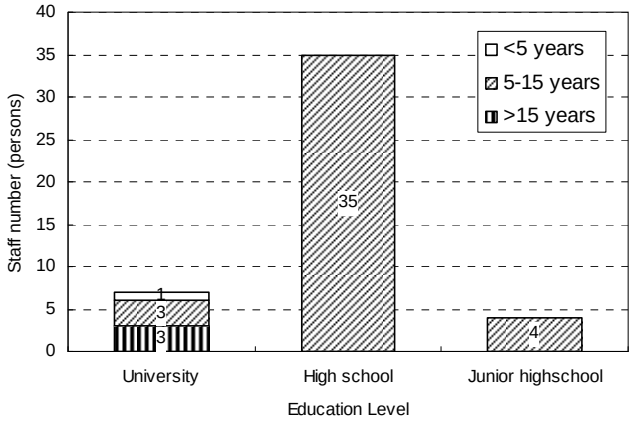
(Note)
P-CERWASS is planning to establish construction and drilling team under technical department.
As of July 2007, it has not been realized yet.

(Source) Ninh Thuan P-CERWASS, July 2007

Figure 12.2.5 Organization Chart of Ninh Thuan P-CERWASS

(3) Education Level and Working Experience

Most staff, 45 out of 46 staff, has more than 5-year experience. On the other hand, there was only one employment of new graduates for this five years. According to director of P-CERWASS, water supply engineer is most needed to recruit since there is no water supply engineer in P-CERWASS and civil engineers substitute so far.



Source: Information from Ninh Thuan P-CERWASS, July 2007

Figure 12.2.6 Number of Staff by Education Level and Work Experience

(4) Staff Training

Staff training is mainly performed through on-the-job training. No particular training course is

provided by P-CERWASS to staff nor operators. Office staffs occasionally attend the training course organized by C-CERWASS.

(5) Financial Status

Since Ninh Thuan P-CERWASS has revenue from water sales, it is financially independent from central and/or provincial budget as shown in the table below. But investment costs are to be borne by central and provincial governments. In year 2007, they received donor fund as a budget for NTP II. Financial status is described in the Main report.

Table 12.2.6 Budgetaty Trend for Ninh Thuan P-CERWASS

(Unit: million VND)

Year	Total Amount	Budget by fund source				
		Central Gov't	Donor Agency	Provincial Gov't	District Gov't	From business (water sales)
2005	460	-	-	-	-	460
2006	610	-	-	-	-	610
2007	1,134	-	-	-	-	1,134

Source: Information from Ninh Thuan P-CERWASS, July 2007

(6) Physical Assets

Physical assets owned by P-CERWASS are summarized in Table.

Table 12.2.7 Major Assets owned by P-CERWASS

Item	Quantity
1. Administration Building	1 Building
2. Vehicles and Machinery	2 Pickup truck (one out of order) 1 Drilling rig (old Chinese rig)
3. Water quality test kit	1 unit (to measure 5-6 parameters)

Source: Information from Ninh Thuan P-CERWASS, July 2007

(7) Water Tariff

Water tariff is set by user category. Tariff is proposed by P-CERWASS and approved by PPC. Same tariff schedule is applied to all 22 systems managed under P-CERWASS.

Table 12.2.8 Water Tariff (applicable from January 2007)

Water source	User category	Tariff
1. Pond, dam, channels	Delta rural area	3,000 VND/m^3
	Mountainous rural area Poor household	2,500 VND/m^3
2. Underground water, gravity system	Delta rural area	2,500 VND/m^3
	Mountainous rural area Poor household	2,000 VND/m^3

Source: Quyet Dinh, 29/2007/QD-UBND, Ninh Thuan PPC

(8) Non Revenue Water

According verbal information from P-CERWASS, there is no case of non-payment compared to total billed water. No information is available for leakage ratio.

(9) Water Quality Control

Water quality of every water supply facility is tested. 9 out of 22 parameters are tested in accordance with Decision 09/2005/QD-BYT. Water quality test is carried out by the science and technology application & telecommunication center, department of science and technology of Ninh Thuan Province.

(10) IEC activity

IEC for sanitation improvement is one of responsibility of P-CERWASS. To date no particular department is in charge of IEC. Instead, all departments are engaged in IEC.

Public awareness on sanitation is said to be insufficient in rural communes in Ninh Thuan. IEC activity shall also be focused and enhanced.

(11) Water Resources Development

Research and well drilling for groundwater development is usually performed by private firms under contract. P-CERWASS owns old drilling rig and plans to establish drilling team under technical department of P-CERWASS.

(12) Prospect of organizational capacity

Due to severer natural conditions, where water resources development is very difficult in Ninh Thuan Province, development and management of rural water supply systems is generally difficult and inefficient. Under the circumstances, Ninh Thuan P-CERWASS has made efforts to manage their 22 existing systems under self-support accounting system.

As for O&M techniques, all of the existing facilities are surface water system. Operators are trained through OJT and familiar with surface water treatment system. However, most existing facilities are old and need rehabilitation. As a result, water treatment is often difficult when raw water become high turbidity. In this sense, P-CERWASS is conscious of upgrading capacity of water quality control through procurement of laboratory equipment and staff training. In this case, external training of short- or mid-term could be applicable, e.g. the urban water corporation and the water sector training center in the south of the construction technical college No.2.

As above explained, Ninh Thuan P-CERWASS as a whole has basic knowledge and skill necessary for operating the proposed water supply system in the Study.

12.2.4 Binh Thuan P-CERWASS

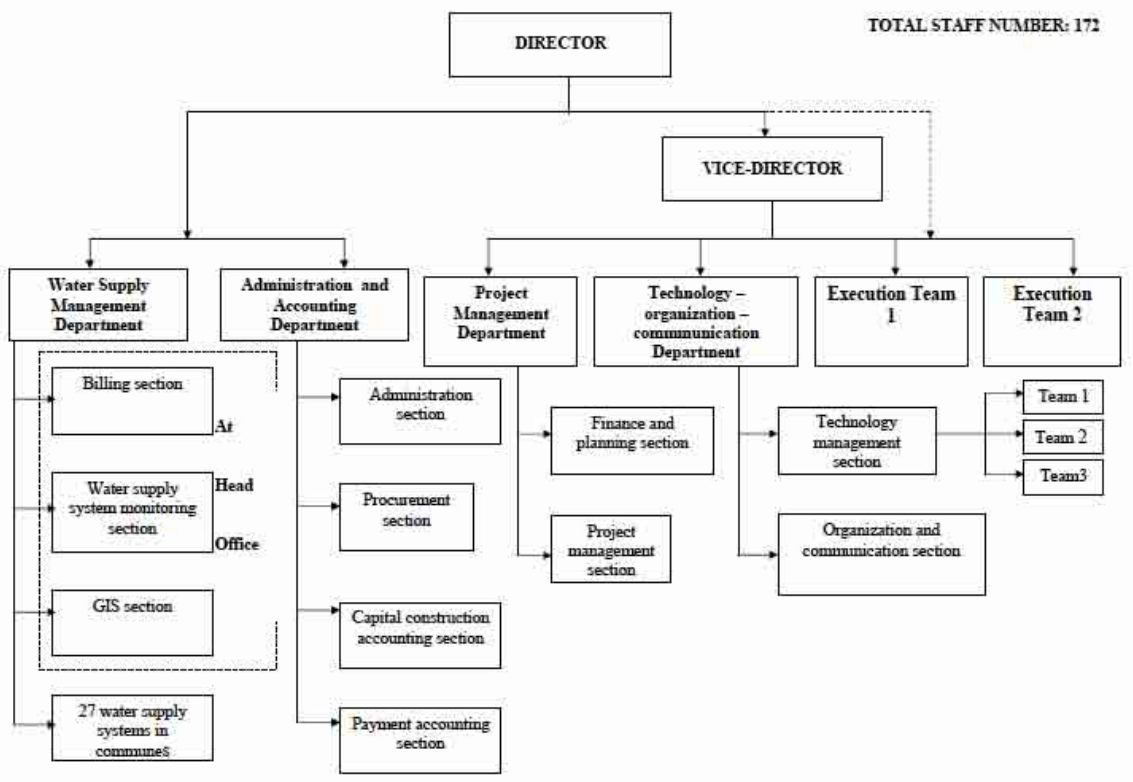
(1) Roles of P-CERWASS

Roles of Binh Thuan P-CERWASS is as same as that of Ninh Thuan. It provides O&M in addition to planning, designing and construction supervision of rural water supply systems.

There are also existing water supply systems which are managed by DPC for the same reasons of Ninh Thuan. Although discussions were made to merge into P-CERWASS management, it has not been realized yet.

(2) Organization Chart

Binh Thuan P-CERWASS was established in 1997, which had formerly been an counterpart office to UNICEF program since 1987. As of July 2007, 172 staff are engaged in Binh Thuan P-CERWASS. Approx. 20 personnel are recruited every year, and most of them are operators.



Source: Binh Thuan P-CERWASS, October 2007

Figure 12.2.7 Organization Chart of Binh Thuan P-CERWASS

Table 12.2.9 Main Duties by Section

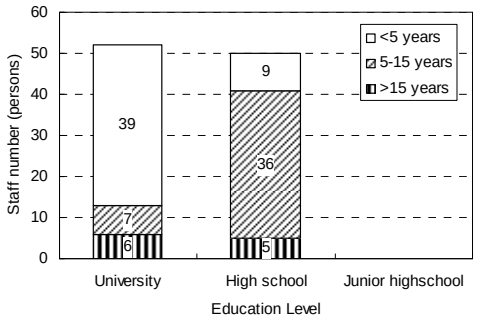
Department	Section	Duty
Water Supply	Customer management	Monthly billing to customers Customer relationship Execution of water cut
	Water supply monitoring	Monitoring O&M activities of 24 systems Preparation of monthly monitoring report
	O&M	Integrated control of management units

		Supply of spare parts Water quality control (every 6 months, test by DOH)
	Water supply management unit	Daily O&M of water supply system Water metering Bill collection Minor repair
Planning, Technology and Organization	Planning, environment and human resources	Preparation of action plan, annual report Public relationship activity (IEC, etc.) Personnel affairs
	Technology and project	Facility design Project management Construction supervision
Accounting	Bank accounting	Handling cash more than VND 3 million
	Casher	Casher
	Financial management	Budget preparation Approval of expenditure
	Procurement	Procurement of materials, equipment and spare parts
Construction team	Team 1 & 2	All construction work under P-CERWASS if it is VND 1 billion. Be able to work other private construction business

Source: Information from Binh Thuan P-CERWASS, July 2007

(3) Education Level and Working Experience

More than 50 staff are university graduates and about 50 are high school graduates. There is a tendency that young staff have higher educational background. It implies that P-CERWASS goes well to attract job applications. New challenges may be how to educate the inexperienced staff.



Source: Information from Binh Thuan P-CERWASS, July 2007

Figure 12.2.8 Number of Staff by Education Level and Work Experience

(4) Staff Training

3-1) Training to operators

Training is regularly performed to operators at every six months to keep and improve their knowledge and skill. Operators attend 2-day course held by the water supply department of P-CERWASS. Courses are graded into two classes; one for skilled and another for unskilled operators. Trainees will take examination at the end of course, which is linked to the contract so that

salary will be cut if they fail exam and even contract will be terminated in case three continuous failure.

3-2) Training to headquarter staff

In the most case, training to office staff is performed through on-the-job training. Although regular training course is not provided by P-CERWASS, special training course for a couple of weeks is occasionally organized by C-CERWASS. Staffs in general seem to have good willingness to educate themselves. And English language education is popular among staffs.

Binh Thuan P-CERWASS introduces staff valuation system, in which every staff is rated for performance at the end of year. And ones who are highly evaluated can be awarded with prize, even though salary shall accord with the government regulation. This system could give staff good incentives as long as credit is fairly given.

(5) Financial Status

Since Binh Thuan P-CERWASS has revenue from water sales, it is financially independent from central and/or provincial budget as shown in the table below. In the past it received some subsidy from central government and budget support by donor agency as the special project fund. Investment costs are to be borne by central and provincial governments. Financial status is detailed in the Main report.

Table 12.2.10 Budgetaty Trend for Binh Thuan P-CERWASS

(Unit: million VND)

Year	Total Amount	Budget by fund source				
		Central Gov't	Donor Agency	Provincial Gov't	District Gov't	From business (water sales)
2005	10,144	34	84	-	-	10,026
2006	12,008	-	4	-	-	12,004
2007	12,800	-	-	-	-	12,800

Source: Information from Binh Thuan P-CERWASS, July 2007

(6) Physical Assets

P-CERWASS owns lands, buildings, water supply facilities, machineries necessary to execute water supply activities. Facilities and lands by state and provincial budget and handed-over to P-CERWASS.

Table 12.2.11 Major Assets owned by P-CERWASS

Item	Quantity
1. Administration Building	1 Building
2. Water supply facility	24 systems with total production capacity of 9,043 m^3/day
3. Vehicles and Machinery	1 Pickup 1 Minibus 1 Lorry 1 Sedan 2 Generator

	1 Drilling rig 2 Air compressor
4. Laboratory	To be equipped in administration buildings
5. Computers	Every section is equipped with PCs.

Source: Information from Binh Thuan P-CERWASS, July 2007

(7) Water Tariff

Water tariff is set by user category. Tariff is proposed by P-CERWASS and approved by PPC. Same tariff schedule is applied for whole systems managed under P-CERWASS.

Table 12.2.12 Water Tariff (applicable from April 2007)

User Category	Tariff
1. Ethnic Minority	1,680 VND/m^3 (VAT 5% inclusive)
2. Others (except category 1)	4,410 VND/m^3 (subject to VAT 5%)
3. Users for production purpose	Not exceeds 5,500 VND/m^3 (to be agreed by both parties)
4. Users for service business	Not exceeds 8,000 VND/m^3 (to be agreed by both parties)

Source: Thong Bao 399/TB-TTN-CN, 10/4/2007

(8) Non Revenue Water

It is informed that approx. 5% of billed water is unpaid by customers. According to regulation, P-CERWASS may cut water supply to customers after nonpayment for two months. Leakage ratio is estimated to be approx. 20% of all production volume.

To date, practical leakage control is not performed by P-CERWASS. But P-CERWASS has willingness to begin leakage control activity by using leakage detection equipment.

(9) Water Quality Control

Water quality of each water supply facility is tested every six months. 15 parameters are tested out of 22 parameters in accordance with Decision 09/2005/QD-BYT.

Water quality test is currently carried out by DOH of Binh Thuan Province. P-CERWASS has prepared a laboratory room in the head office so that water quality test will be done by P-CERWASS after test equipment arrives.

(10) IEC activity

For sanitation improvement, P-CERWASS mainly focus on IEC which is in charge of the planning, environment and human resources section of the planning, technology and organization department. Approx. VND 300 million is annually allocated for IEC from state budget.

(11) Water Resources Development

Research and well drilling for groundwater development is usually performed by private firms under contract, although P-CERWASS is said to be fully capable of these tasks.

(12) Document and Information Management

Document and information management seems to be properly done in accordance with ISO 9001 requirements. Most information is easy to access.

It is notable that GIS software is effectively used to manage facility data as well as customer information. Geographical data is accurate and every data is always updated by the all staff of water supply department. P-CERWASS is planning to improve the GIS system to integrate with the billing system, which enables further efficient customer management.

(13) Prospect of organizational capacity

In fact, Binh Thuan P-CERWASS would be one of the most successful CERWASS in the country. Their management policy and O&M practice is sufficient level and even far ahead of other P-CERWASS in any aspects. It is notable that the P-CERWASS introduces ISO quality management system in their business which is functioning well to guarantee and improve not only water quality but also water supply service itself.

Hence, Binh Thuan P-CERWASS is capable of O&M of water supply facilities proposed in the Study. And it is also expected that Binh Thuan P-CERWASS, as the model waterworks, has good influence to the P-CERWASS of other provinces.

CHAPTER 13

SELECTION OF THE TARGET COMMUNES FOR FS

CHAPTER 13 SELECTION OF THE TARGET COMMUNES FOR FS

13.1 Evaluation for Priority Commune

The detailed selection of the target communes for F/S is showed in the below.

Table 13.1.1 Reslts and Calculated Data for Assessment Criteria

Province	Code	Commune	Scarcity of Potable Water												Effectiveness to poverty reduction		Active participation of the community							Technical rationality to install house connection using groundwater								
			Fetching water in dry season*1						Rate of population served	Satisfaction level of available water*2					Rate of poverty	Rate of ethnic group	Willingness to pay / Affordability*3						Project ownership	Population	Affordability to connection fee*4						Rate of households having toilet
			(%)					(min)		(%)					(%)	(%)	(%)					(VND)		(Persons)	(%)					(VND)	(%)
			Less than 5 min.	5-10 min.	10-30min.	30-60min.	More than 60min.	Expectation		Good quality	Acceptable	Not good	Very bad	Expectation			Less than 30	30-50	50-80	80-100	More than 100	Expectation			Less than 300	300-500	500-800	800-1,000	More than 1,000	Expectation	
Phu Yen	P-1	Xuan Phuoc	41.7%	38.3%	17.8%	1.1%	1.1%	8.6	0%	27.8%	23.3%	30.6%	17.8%	1.3	20.9%	4.2%	66.7%	25.0%	6.7%	1.7%	0.0%	25,833	No organization No plan for establishment	10,927	59.4%	25.0%	5.0%	7.2%	3.3%	320,000	17.2%
	P-2	An Dinh	54.8%	16.1%	13.5%	14.2%	1.3%	12.5	0%	100.0%	0.0%	0.0%	0.0%	3.0	13.9%	0.0%	61.3%	9.0%	10.3%	11.6%	7.7%	37,710	No organization CPC has plan for establishment	6,856	49.7%	20.0%	13.5%	9.0%	7.7%	401,290	31.0%
	P-3	An Tho	36.5%	20.3%	21.6%	20.3%	1.4%	16.7	6%	9.1%	54.5%	36.4%	0.0%	1.4	29.0%	0.0%	83.8%	9.5%	4.1%	2.7%	0.0%	21,419	No organization Residents have experience of O&M	4,373	24.3%	47.3%	9.5%	12.2%	6.8%	464,189	9.5%
	P-4	An My	18.1%	19.1%	52.5%	8.2%	2.1%	17.3	0%	67.7%	3.5%	21.9%	7.0%	2.1	9.7%	0.0%	75.2%	22.3%	2.1%	0.0%	0.4%	21,950	No organization No plan for establishment	13,256	51.8%	23.8%	14.5%	5.0%	5.0%	361,525	38.7%
	P-5	Son Phuoc	63.8%	17.4%	18.8%	0.0%	0.0%	6.7	24%	27.3%	18.2%	36.4%	18.2%	1.2	28.2%	58.5%	60.9%	23.2%	5.8%	5.8%	4.3%	31,739	No organization CPC has plan for establishment	3,101	52.2%	11.6%	10.1%	10.1%	15.9%	441,304	4.3%
	P-6	Ea Cha Rang	32.2%	18.6%	37.3%	6.8%	5.1%	15.8	0%	100.0%	0.0%	0.0%	0.0%	3.0	41.0%	73.7%	62.7%	23.7%	1.7%	5.1%	6.8%	31,356	No organization CPC has plan for establishment	2,624	54.2%	18.6%	15.3%	5.1%	6.8%	368,644	5.1%
	P-7	Suoi Bac	29.0%	27.6%	20.7%	9.0%	13.8%	19.2	11%	80.9%	14.9%	4.3%	0.0%	2.7	30.0%	30.5%	84.0%	15.1%	0.9%	0.0%	0.0%	19,245	No organization CPC has plan for establishment	6,411	42.8%	26.2%	17.2%	5.5%	8.3%	413,448	44.8%
	P-8	Son Thanh Dong	73.5%	21.2%	4.2%	1.1%	0.0%	4.7	0%	2.1%	0.0%	0.0%	0.0%	0.1	25.0%	0.1%	58.2%	31.2%	5.8%	2.1%	2.6%	29,550	No organization CPC has plan for establishment	9,292	49.2%	23.3%	7.4%	9.0%	11.1%	407,143	12.7%
Khanh Hoa	K-1	Cam An Bac	70.9%	22.2%	6.0%	0.9%	0.0%	5.0	20%	90.0%	10.0%	0.0%	0.0%	2.9	22.0%	0.0%	85.5%	11.1%	3.4%	0.0%	0.0%	19,487	No organization CPC has plan for establishment	6,462	59.0%	26.5%	8.5%	5.1%	0.9%	304,701	40.2%
	K-2	Cam Hiep Nam	18.5%	41.5%	32.3%	5.4%	2.3%	13.8	0%	14.3%	21.4%	57.1%	7.1%	0.9	15.8%	0.0%	62.3%	33.8%	3.1%	0.8%	0.0%	25,577	No organization CPC has plan for establishment	7,962	49.2%	40.0%	5.4%	0.8%	4.6%	321,923	63.8%
	K-3	Cam Hai Tay	15.0%	42.5%	16.7%	13.7%	12.0%	20.3	0%	6.5%	88.6%	5.0%	0.0%	2.0	9.0%	0.0%	36.5%	43.3%	14.6%	2.1%	3.4%	37,661	No organization CPC has plan for establishment	6,978	35.2%	37.8%	18.9%	3.0%	5.2%	405,150	70.8%
Ninh Thuan	N-1	Nhon Hai	41.7%	38.3%	19.2%	0.4%	0.4%	8.2	0%	0.4%	67.9%	31.7%	0.0%	1.4	13.0%	0.0%	12.9%	36.7%	33.8%	12.1%	4.6%	54,000	No organization CPC has plan for establishment	20,413	5.4%	41.7%	35.8%	14.6%	2.5%	563,958	56.3%
	N-2	Cong Hai	33.6%	19.5%	32.9%	13.4%	0.7%	15.3	0%	4.0%	44.0%	36.0%	16.0%	1.0	25.3%	46.2%	54.4%	36.9%	8.7%	0.0%	0.0%	28,591	No organization No plan for establishment	9,776	47.0%	37.6%	9.4%	4.7%	1.3%	337,584	7.4%
	N-3	Bac Son	54.6%	5.4%	23.1%	11.5%	5.4%	14.8	71%	23.4%	26.0%	41.6%	7.8%	1.2	32.0%	76.6%	81.5%	15.4%	3.1%	0.0%	0.0%	20,385	CPC has managed the existing system	4,661	69.2%	20.8%	3.8%	4.6%	1.5%	268,846	5.4%
	N-5	Phuoc Hai	78.3%	8.3%	12.6%	0.0%	0.9%	5.6	35%	3.2%	22.6%	58.1%	16.1%	0.5	16.0%	31.2%	73.5%	24.3%	1.7%	0.0%	0.4%	22,326	CPC has WMU for existing system	16,804	34.3%	47.0%	12.6%	3.5%	2.6%	378,696	57.8%
	N-6	Phuoc Dinh	44.9%	32.9%	16.5%	3.8%	1.9%	9.7	19%	17.7%	58.2%	24.1%	0.0%	1.7	20.0%	0.1%	51.3%	40.5%	5.7%	1.3%	1.3%	30,000	No organization No plan for establishment	12,911	60.8%	36.1%	1.9%	0.0%	1.3%	260,443	53.2%
Binh Thuan	B-1	Muong Man	50.0%	17.1%	17.1%	9.3%	6.4%	14.0	0%	32.8%	43.8%	21.9%	0.0%	1.9	6.3%	0.0%	30.7%	54.3%	9.3%	2.1%	3.6%	37,857	No organization CPC has plan for establishment	7,378	32.1%	44.3%	7.1%	7.9%	8.6%	428,214	54.3%
	B-2	Gia Huynh	77.1%	16.9%	5.1%	0.8%	0.0%	4.6	2%	0.0%	30.3%	33.3%	36.4%	0.6	8.4%	9.6%	51.7%	21.2%	8.5%	9.3%	9.3%	39,449	No organization CPC has plan for establishment	6,139	36.4%	50.0%	6.8%	5.1%	1.7%	361,441	33.9%
	B-3	Nghi Duc	24.6%	60.6%	13.8%	0.5%	0.5%	8.4	0%	1.5%	34.5%	32.5%	28.6%	0.7	8.1%	0.0%	66.5%	30.5%	3.0%	0.0%	0.0%	24,113	No organization CPC has plan for establishment	11,869	46.3%	45.3%	6.9%	0.5%	1.0%	309,852	28.1%
	B-4	Tan Duc	76.7%	13.8%	5.2%	1.7%	2.6%	6.3	47%	19.0%	22.4%	7.8%	50.9%	1.0	30.0%	6.3%	43.1%	36.2%	12.1%	3.4%	5.2%	37,069	No organization No plan for establishment	6,068	39.7%	23.3%	16.4%	15.5%	5.2%	450,431	41.4%
	B-5	Me Pu	67.0%	5.6%	4.8%	3.7%	18.9%	16.1	0%	0.0%	82.9%	17.1%	0.0%	1.7	9.8%	2.9%	63.7%	30.0%	3.7%	1.9%	0.7%	26,370	No organization No plan for establishment	16,315	37.8%	37.4%	7.8%	10.7%	6.3%	416,481	49.6%
	B-6	Sung Nhon	100.0%	0.0%	0.0%	0.0%	0.0%	2.5	0%	0.0%	0.0%	0.0%	0.0%	0.0	12.0%	2.2%	95.8%	3.6%	0.6%	0.0%	0.0%	16,212	No organization CPC has plan for establishment	9,794	62.4%	32.7%	1.8%	1.8%	1.2%	264,848	44.8%
	B-7	Da Kai	34.2%	20.9%	29.5%	10.3%	5.1%	16.0	0%	15.0%	36.3%	23.9%	13.7%	1.2	23.0%	2.9%	69.2%	21.8%	4.3%	2.1%	2.6%	26,368	No organization No plan for establishment	14,263	47.9%	34.6%	6.4%	8.5%	2.6%	354,487	51.7%

Note: *1, 2, 3, 4: Expectation values ware calculated by weighted average, based on assumed values mentioned below.
*1: Less than 5min: 2.5 min, 5-10min: 7.5min, 10-30min: 20min, 30-60min: 45min, More than 60min: 60min
*2: Good quality: 3pts, Acceptable: 2pts, Not good: 1pt, Very bad: 0pt
*3: Less than 30: 15,000VND, 30-50: 40,000VND, 50-80: 65,000VND, 80-100: 90,000VND, More than 100: 100,000VND
*4: Less than 300: 150,000VND, 300-500: 400,000VND, 500-800: 650,000VND, 800-1,000: 900,000VND, More than 1,000: 1,000,000VND

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). Each index is defined as follows:

(i) Relevance: Relevance to national policy
(ii) Effectiveness: Effectiveness of the Project
(iii) Efficiency: Efficiency of the Project (Input and accomplishment)
(iv) Impact: Positive and negative impact on socio-economic aspect by the project
(v) Sustainability: Sustainability of water supply system and management

The estimated magnitude of criteria on the basis of DAC indices is shown in Table 13.1.2. According to the estimated magnitude of criteria, the assessment score is defined. In most cases, the assessment score of criteria is classified into three (3) by quartile range. However, since the collected data for some items are not quantitative, the qualitative evaluation has been adopted for those criteria. Based on the criteria and magnitude, assessment score is summarized in Table 13.1.3. In case when criteria related to 3 out of DAC's 5 indices, they are weighted 5 points and others are weighted 3 points.

Table 13.1.2 Estimated Magnitude of Criteria by DAC Indices

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	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 m^3 (VND)	X	X	X	X	X	5

Table 13.1.3 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 Enough	3pts marginal in dry season	1pt not enough
	E-2	Water quality	5pts No treatment Including disinfection)	3pts Requires normal treatment (Removal of Iron and Turbidity)	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	F1 Financial conditions				
	F-1	Construction cost per m3 (VND)	5 pts Less than 2 million	3 pts from 2 to 5million	1 pt more than 5 million

Note: Except for C-2, range for each assessment point is determined by result of quartiles of results or calculated data in Table 13.1.1.

Table 13.1.4 Scoring for the Estimation of Socio-economic Conditions for Each Commune

Province	Code	Commune	Scarcity of Potable Water						Effectiveness to poverty reduction				Active participation of the community					Technical rationality to install house connection using groundwater					
			A-1		A-2		A-3		B-1		B-2		C-1		C-2			D-1		D-2		D-3	
			Fetching water in dry season		Rate of population served		Satisfaction level of available water		Rate of poverty		Rate of ethnic group		Willingness to pay / Affordability		Project ownership			Population		Affordability to connection fee		Rate of households having toilet	
			(min)	points	(%)	points	-	points	(%)	points	(%)	points	(VND)	points	organization	plan	points	(Persons)	points	(VND)	points	(%)	points
Phu Yen	P-1	Xuan Phuoc	8.6	1	0%	3	1.3	2	20.9%	2	4.2%	1	25,833	2	0	0	1	10,927	5	320,000	2	17.0%	2
	P-2	An Dinh	12.5	3	0%	3	3.0	1	13.9%	2	0.0%	1	37,710	3	0	1	2	6,856	3	401,290	3	31.0%	2
	P-4	An My	17.3	5	0%	3	2.1	1	9.7%	1	0.0%	1	21,950	2	0	0	1	13,256	5	361,525	2	38.7%	2
	P-5	Son Phuoc	6.7	1	24%	1	1.2	2	28.2%	3	58.5%	3	31,739	2	0	1	2	3,101	1	441,304	3	4.3%	1
	P-6	Ea Cha Rang	15.8	5	0%	3	3.0	1	41.0%	3	73.7%	3	31,356	2	0	1	2	2,624	1	368,644	2	5.1%	1
	P-7	Suoi Bac	19.2	5	11%	2	2.7	1	30.0%	3	30.5%	3	19,245	1	0	1	2	6,411	3	413,448	3	44.8%	2
	P-8	Son Thanh Dong	4.7	1	0%	3	0.1	3	25.0%	3	0.1%	1	29,550	2	0	1	2	9,292	3	407,143	3	12.7%	1
Khanh Hoa	K-1	Cam An Bac	5.0	1	20%	1	2.9	1	22.0%	2	0.0%	1	19,487	1	0	1	2	6,462	3	304,701	2	40.2%	2
	K-3	Cam Hai Tay	20.3	5	0%	3	2.0	1	9.0%	1	0.0%	1	37,661	3	0	1	2	6,978	3	405,150	3	70.8%	3
Ninh Thuan	N-5	Phuoc Hai	5.6	1	35%	1	0.5	3	16.0%	2	31.2%	3	22,326	2	1	1	3	16,804	5	378,696	2	57.8%	3
	N-6	Phuoc Dinh	9.7	1	19%	2	1.7	2	20.0%	2	0.1%	1	30,000	2	0	0	1	12,911	5	260,443	1	53.2%	3
Binh Thuan	B-1	Muong Man	14.0	3	0%	3	1.9	2	6.3%	1	0.0%	1	37,857	3	0	1	2	7,378	3	428,214	3	54.3%	3
	B-3	Nghi Duc	8.4	1	0%	3	0.7	3	8.1%	1	0.0%	1	24,113	2	0	1	2	11,869	5	309,852	2	28.1%	2
	B-5	Me Pu	16.1	5	0%	3	1.7	2	9.8%	1	2.9%	1	26,370	2	0	0	1	16,315	5	416,481	3	49.6%	2
	B-6	Sung Nhon	2.5	1	0%	3	0.0	3	12.0%	2	2.2%	1	16,212	1	0	1	2	9,794	3	264,848	1	44.8%	2
	B-7	Da Kai	16.0	5	0%	3	1.2	2	23.0%	2	2.9%	1	26,368	2	0	0	1	14,263	5	354,487	2	51.7%	3

<C-2 Organization>
0 pt; No organization
1 pt; CPC has organization regarding water supply

<C-2 Plan>
0pt; No plan
1pt; CPC has plan for establishment or CPC has experience for O&M

<C-2 points>
Total score of organization and plan is;
0: 1pts
1: 2pts
2: 3pts

Table 13.1.5 Scoring for the Estimation of Socio-economic Con

Province	Code	System	Scarcity of Potable Water						Effectiveness to poverty reduction				Active partic									onnection using groundwater	
			A-1		A-2		A-3		B-1		B-2		C-1									D-3	
			Fetching water in dry season		Rate of population served		Satisfaction level of available water		Rate of poverty		Rate of ethnic group		Willingness to pay / Affordability		Project ownership			Population		Affordability to connection fee		Rate of households having toilet	
			(min)	points	(%)	points	-	points	(%)	points	(%)	points	(VND)	points	organization*1	plan*2	points	(Persons)	points	(VND)	points	(%)	points
Phu Yen	P-1	FPS-1	8.6	1	0.0%	3	1.3	2	21.0%	2	4.0%	1	25,833	2	0	0	1	10,927	5	320,000	2	17.0%	2
	P-2	FPS-2	12.5	3	0.0%	3	3.0	1	14.0%	2	0.0%	1	37,710	3	0	1	2	6,856	3	401,290	3	31.0%	2
	P-4	FPS-3	17.3	5	0.0%	3	2.1	1	9.7%	1	0.0%	1	21,950	2	0	0	1	13,256	5	361,525	2	38.7%	2
	P-5,6,7	FPG-4	15.3	5	12.0%	2	2.4	1	32.0%	3	47.0%	3	25,056	2	0	1	2	12,136	5	410,878	3	26.0%	2
	P-8	FPS-5	4.7	1	0.0%	3	0.1	3	25.0%	3	0.1%	1	29,550	2	0	1	2	9,292	3	407,143	3	12.7%	1
Khanh Hoa	K-1	FKS-6	5.0	1	20.0%	1	2.9	1	22.0%	2	0.0%	1	19,487	1	0	1	2	6,462	3	304,701	2	40.2%	2
	K-3	FKS-8	20.3	5	0.0%	3	2.0	1	9.0%	1	0.0%	1	37,661	3	0	1	2	6,978	3	405,150	3	70.8%	3
Ninh Thuan	N-5,6	FNG-10	7.4	1	28.0%	1	1.0	2	18.0%	2	18.0%	3	25,660	2	1	1	3	29,715	5	327,316	2	56.0%	3
Binh Thuan	B-1	FBS-11	14.0	3	0.0%	3	1.9	2	6.3%	1	0.0%	1	37,857	3	0	1	2	7,378	3	428,214	3	54.3%	3
	B-3,5,6,7	FBG-13	11.8	3	0.0%	3	1.0	2	13.0%	2	2.0%	1	23,952	2	0	0	1	52,241	5	346,902	2	44.0%	2

Table 13.1.6 Evaluation of Socio-economic Conditions

Province	Code	Scarcity of Potable Water	Effectiveness to poverty reduction	Active participation of the community	Technical rationality to install house connection using groundwater	Total
Phu Yen	P-1	6	3	3	9	21
	P-2	7	3	5	8	23
	P-4	9	2	3	9	23
	P-5,6,7	8	6	4	10	28
	P-8	7	4	4	7	22
Khanh Hoa	K-1	3	3	3	7	16
	K-3	9	2	5	9	25
Ninh Thuan	N-5,6	4	5	5	10	24
Binh Thuan	B-1	8	2	5	9	24
	B-3,5,6,7	8	3	3	9	23

Table 13.1.7 Evaluation for Priority Commune (Groundwater Sources)

Facility No.	Commune	(1) Score of socio-economic conditions	(2) Technical conditions			(3) Financial conditions	Total Score (1)+(2)+(3)
			(2-1) Water yield of test well	(2-2) Raw water quality	(2-3) Difficulty in well construction		
FPS-3	P-4	23	5	5	3	5	**41**
FPS-5	P-8	22	5	5	5	5	**42**
FKS-6	K-1	16	5	3	3	5	**32**

Table 13.1.8 Evaluation for Priority Commune (Alternative Water Sources)

Facility No.	Commune	(1) Score of socio-economic conditions	(2) Technical conditions					(3) Financial conditions	Total Score (1)+(2)+(3)
			(2-1) Raw water flow capacity	(2-2) Raw water quality	(2-3) Difficulty in intake construction	(2-4) Distance between intake and service area	(2-5) Difficulty in transmission pipe construction		
FPS-1	P-1	21	5	3	1	1	1	1	**33**
FPS-2	P-2	23	5	3	5	5	3	3	**47**
FPG-4	P-5,6,7	28	5	3	1	5	1	5	**48**
FKS-8	K-3	25	5	3	3	5	1	1	**43**
FNG-10	N-5,6	24	5	3	1	3	1	3	**40**
FBS-11	B-1	24	5	3	3	5	3	3	**46**
FBG-13	B-3,5,6,7	23	5	3	1	5	5	5	**47**

(Note) Scoring

(1) Socio -economic conditions

Total score of evaluation in the 1st fiscal year study

(2) Technical conditions

2-1) Raw water flow capacity
- 1pt: Not enough
- 3pts: Marginal in dry season
- 5pts: Good

2-2) Raw Water quality
- 1pt: High risk of contaminated by heavy metal or pesticide
- 3pts: Requires normal treatment
- 5pts: No treatment

2-3) Difficulty in intake construction
- 1pt: River intake
- 3pts: Connection with irrigation channel
- 5pts: Connection with exiting pipe

2-4) Distance between intake and service area
- 1pt: 15km < X
- 3pts: 10km < X < 15km
- 5pts: X < 10km

2-5) Difficulty in transmission pipe construction
- 1pt: Crossing big river or national road (class I)
- 3pts: Crossing railway or small river
- 5pts: Not found

(3) Financial conditions

Construction cost per population served (X)
- 1pt: VND 4.0 million < X
- 3pts: VND 3 million < X < VND 4 million
- 5pts: X < VND 3 million

CHAPTER 14

PIPE NETWORK ANALYSIS

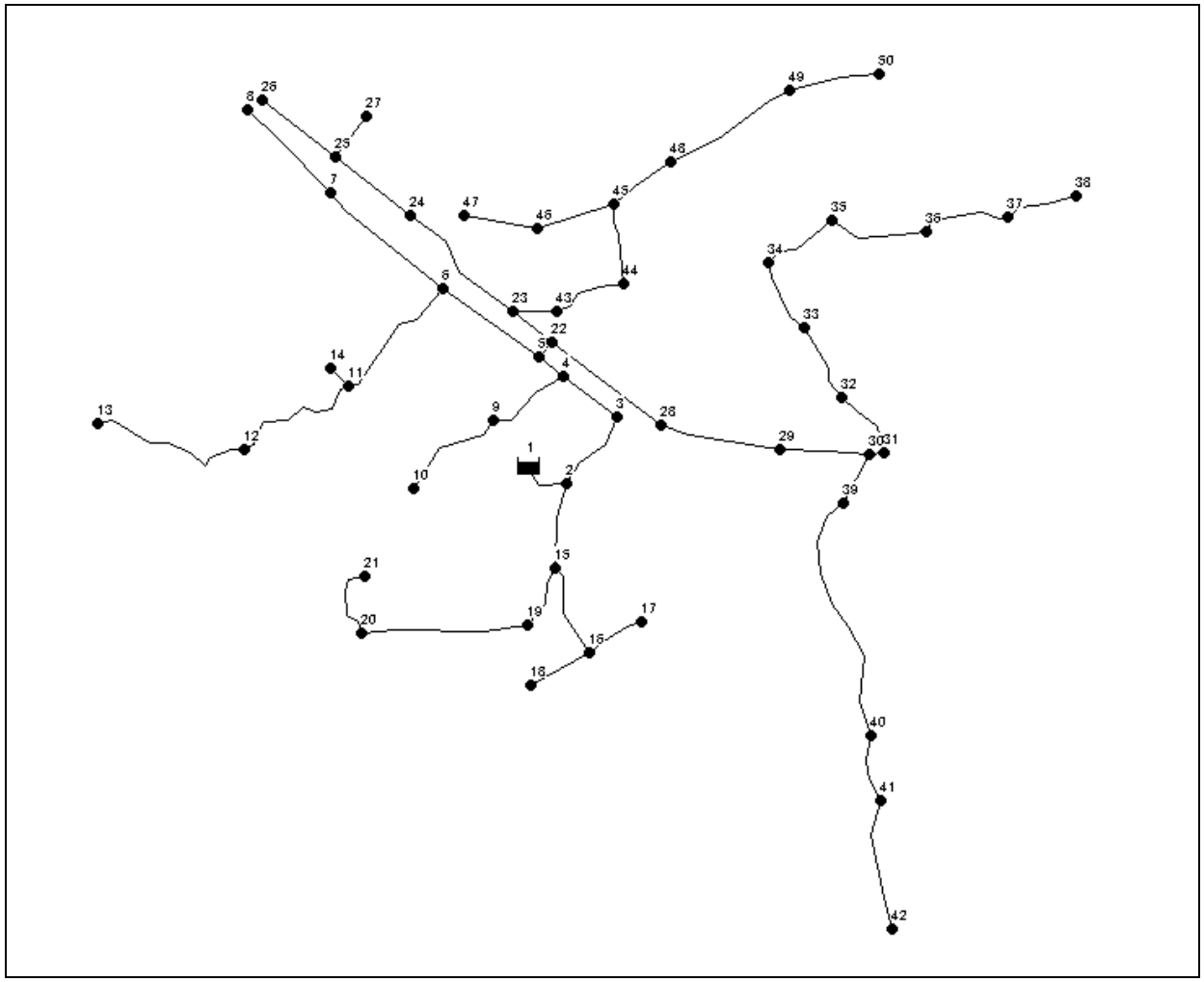
CHAPTER 14 PIPE NETWORK ANALYSIS

14.1 FPS-2

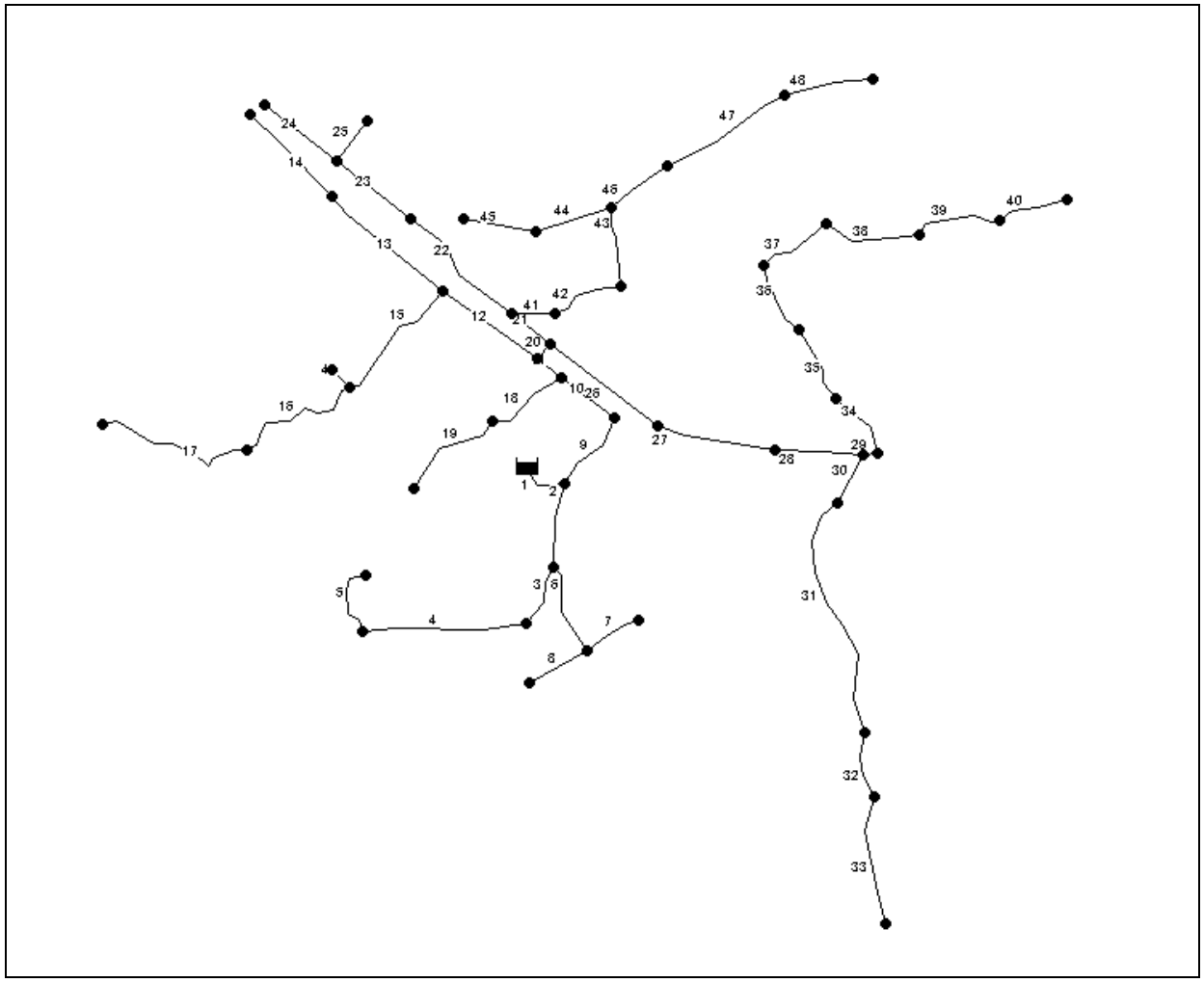
(1) Result of distribution network analysis

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	41		-1200.6	41.0	0.0	Pipe 1	213.7	200	110	1200.6	0.4	1.6
Junc 2	10	18.3	36.6	40.7	30.7	Pipe 2	384.9	65	110	170.8	0.6	10.5
Junc 3	10	12.2	24.4	40.2	30.2	Pipe 3	289.5	50	110	73.2	0.4	7.9
Junc 4	20	12.2	24.4	39.9	19.9	Pipe 4	740.3	50	110	48.8	0.3	3.7
Junc 5	15	12.2	24.4	39.8	24.8	Pipe 5	349.6	50	110	24.4	0.1	1.0
Junc 6	10	12.2	24.4	39.6	29.6	Pipe 6	423.5	50	110	73.2	0.4	7.9
Junc 7	15	12.2	24.4	39.5	24.5	Pipe 7	269.5	50	110	24.4	0.1	1.0
Junc 8	15	12.2	24.4	39.5	24.5	Pipe 8	294.1	50	110	24.4	0.1	1.0
Junc 9	25	12.2	24.4	38.5	13.5	Pipe 9	386.6	200	110	993.2	0.4	1.2
Junc 10	30	12.2	24.4	37.9	7.9	Pipe 10	302.2	200	110	968.8	0.4	1.1
Junc 11	10	6.1	12.2	39.4	29.4	Pipe 11	134.7	200	110	895.6	0.3	1.0
Junc 12	10	12.2	24.4	39.3	29.3	Pipe 12	526.6	125	110	146.4	0.1	0.3
Junc 13	20	12.2	24.4	39.3	19.3	Pipe 13	658.0	100	110	48.8	0.1	0.1
Junc 14	15	6.1	12.2	39.4	24.4	Pipe 14	521.5	100	110	24.4	0.0	0.0
Junc 15	10	12.2	24.4	36.6	26.6	Pipe 15	629.7	100	110	73.2	0.1	0.3
Junc 16	20	12.2	24.4	33.3	13.3	Pipe 16	623.7	100	110	48.8	0.1	0.1
Junc 17	20	12.2	24.4	33.0	13.0	Pipe 17	727.4	100	110	24.4	0.0	0.0
Junc 18	20	12.2	24.4	33.0	13.0	Pipe 18	384.2	50	110	48.8	0.3	3.7
Junc 19	10	12.2	24.4	34.3	24.3	Pipe 19	495.6	50	110	24.4	0.1	1.0
Junc 20	15	12.2	24.4	31.6	16.6	Pipe 20	90.9	200	110	724.8	0.3	0.6
Junc 21	20	12.2	24.4	31.2	11.2	Pipe 21	226.0	125	110	339.2	0.3	1.6
Junc 22	10	12.2	24.4	39.7	29.7	Pipe 22	640.6	50	110	48.8	0.3	3.7
Junc 23	10	24.4	48.8	39.3	29.3	Pipe 23	420.3	50	110	48.8	0.3	3.7
Junc 24	0	0.0	0.0	37.0	37.0	Pipe 24	410.3	50	110	24.4	0.1	1.0
Junc 25	0	0.0	0.0	35.4	35.4	Pipe 25	228.2	50	110	24.4	0.1	1.0
Junc 26	15	12.2	24.4	35.0	20.0	Pipe 26	606.7	125	110	361.2	0.3	1.7
Junc 27	10	12.2	24.4	35.2	25.2	Pipe 27	545.2	125	110	361.2	0.3	1.7
Junc 28	10	0.0	0.0	38.6	28.6	Pipe 28	398.7	125	110	361.2	0.3	1.7
Junc 29	10	0.0	0.0	37.7	27.7	Pipe 29	61.5	125	110	239.2	0.2	0.8
Junc 30	20	12.2	24.4	37.0	17.0	Pipe 30	249.0	80	110	97.6	0.2	1.4
Junc 31	20	12.2	24.4	36.9	16.9	Pipe 31	1143.8	80	110	73.2	0.2	0.8
Junc 32	15	23.2	46.4	36.3	21.3	Pipe 32	302.5	80	110	48.8	0.1	0.4
Junc 33	20	23.2	46.4	35.8	15.8	Pipe 33	588.9	80	110	24.4	0.1	0.1
Junc 34	10	12.2	24.4	35.6	25.6	Pipe 34	327.7	100	110	214.8	0.3	2.0
Junc 35	15	12.2	24.4	35.4	20.4	Pipe 35	365.4	100	110	168.4	0.3	1.3
Junc 36	20	12.2	24.4	35.3	15.3	Pipe 36	339.9	100	110	122.0	0.2	0.7
Junc 37	20	12.2	24.4	35.3	15.3	Pipe 37	342.2	100	110	97.6	0.1	0.5
Junc 38	20	12.2	24.4	35.3	15.3	Pipe 38	445.7	100	110	73.2	0.1	0.3
Junc 39	25	12.2	24.4	36.7	11.7	Pipe 39	407.2	80	110	48.8	0.1	0.4
Junc 40	15	12.2	24.4	35.7	20.7	Pipe 40	320.1	80	110	24.4	0.1	0.1
Junc 41	20	12.2	24.4	35.6	15.6	Pipe 41	194.9	125	110	241.6	0.2	0.8
Junc 42	20	12.2	24.4	35.6	15.6	Pipe 42	339.5	125	110	192.8	0.2	0.5
Junc 43	10	24.4	48.8	39.2	29.2	Pipe 43	354.4	125	110	168.4	0.2	0.4
Junc 44	10	12.2	24.4	39.0	29.0	Pipe 44	359.1	50	110	48.8	0.3	3.7
Junc 45	10	12.2	24.4	38.8	28.8	Pipe 45	334.5	50	110	24.4	0.1	1.0
Junc 46	10	12.2	24.4	37.5	27.5	Pipe 46	318.9	80	110	95.2	0.2	1.3
Junc 47	10	12.2	24.4	37.2	27.2	Pipe 47	615.9	80	110	48.8	0.1	0.4
Junc 48	10	23.2	46.4	38.4	28.4	Pipe 48	407.7	80	110	24.4	0.1	0.1
Junc 49	10	12.2	24.4	38.2	28.2	Pipe 49	114.2	50	110	12.2	0.1	0.3
Junc 50	10	12.2	24.4	38.2	28.2							

(2) Location of junctions



(3) Location of links

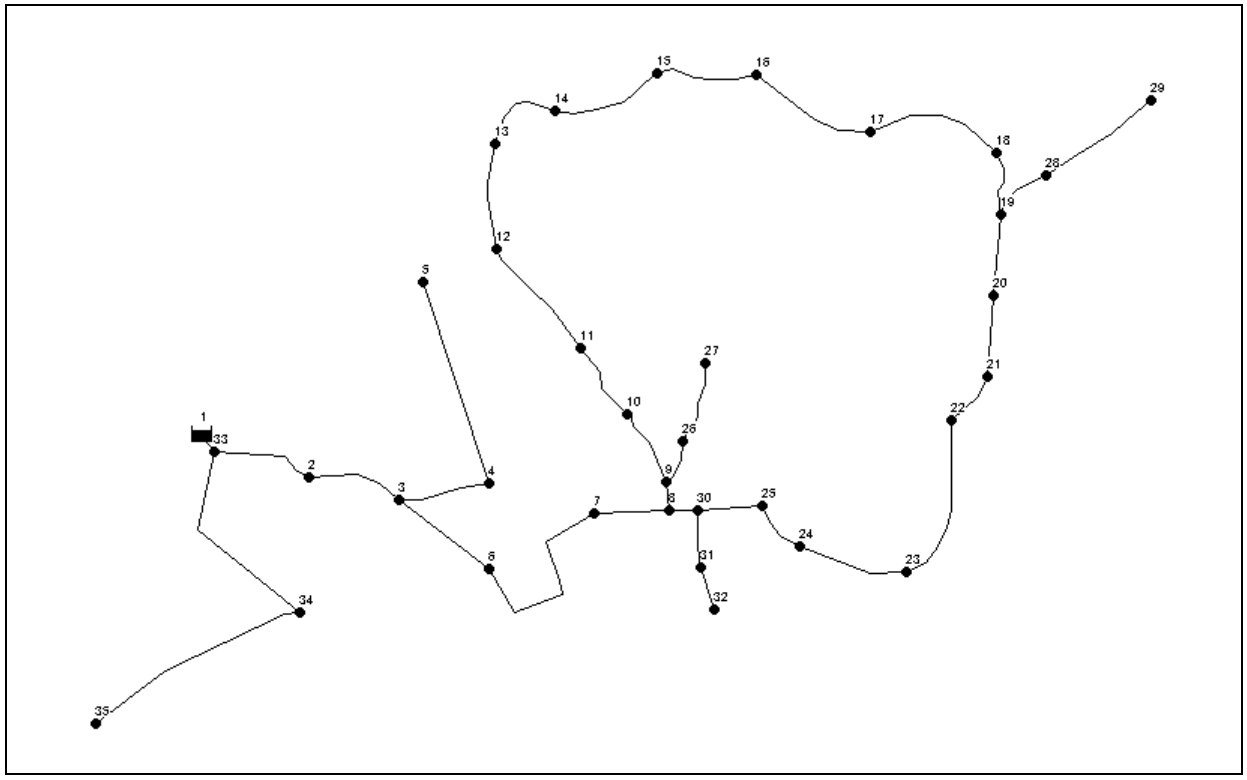


14.2 FPS-3

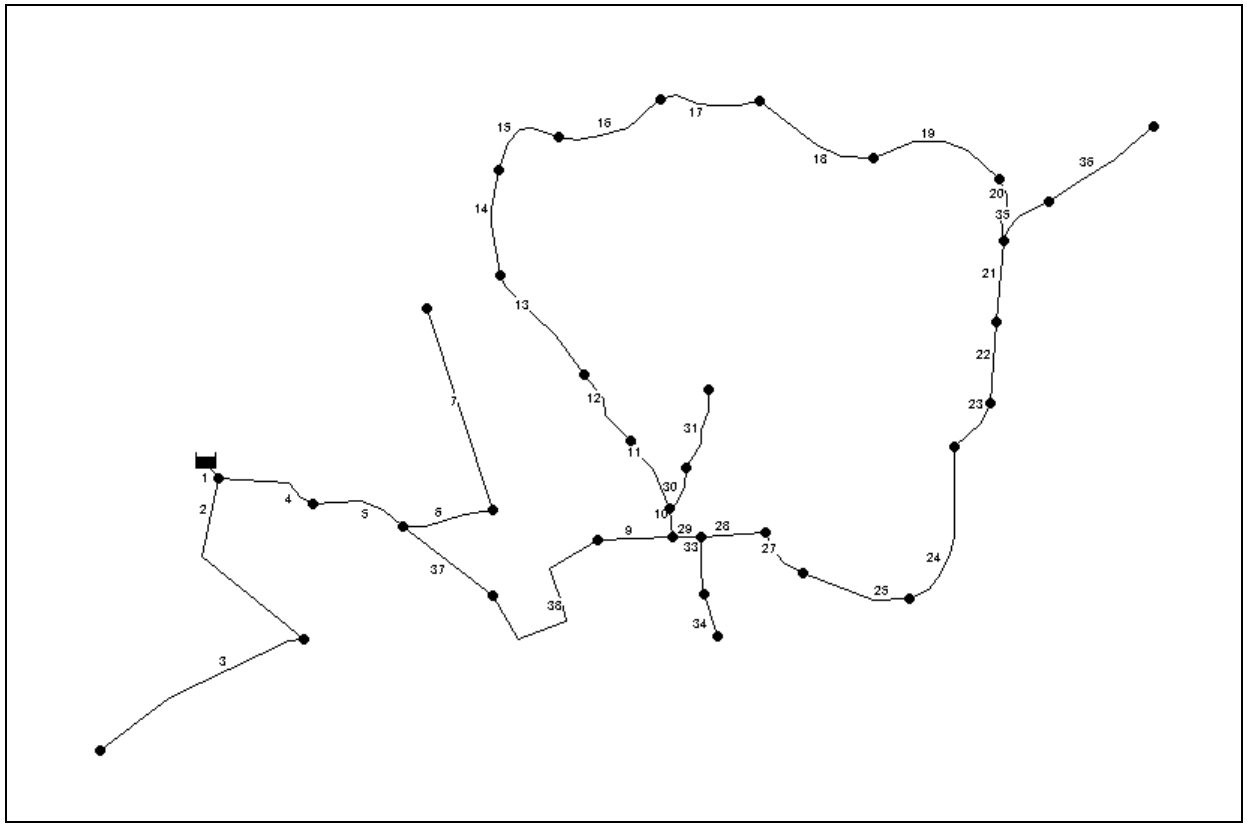
(1) Result of distribution network analysis

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	54		−2402.4	54.0	0.0	Pipe 1	77.8	250	110	2402.4	0.6	2.0
Junc 2	20	36.4	72.8	53.1	33.1	Pipe 2	787.7	50	110	60.8	0.4	5.6
Junc 3	10	36.4	72.8	52.5	42.5	Pipe 3	879.2	50	110	40.0	0.2	2.6
Junc 4	10	36.4	72.8	42.9	32.9	Pipe 4	384.7	250	110	2341.6	0.6	1.9
Junc 5	10	36.4	72.8	36.7	26.7	Pipe 5	368.6	250	110	2268.8	0.5	1.8
Junc 6	10	36.4	72.8	51.8	41.8	Pipe 6	340.4	50	110	145.6	0.9	28.1
Junc 7	10	36.4	72.8	50.7	40.7	Pipe 7	794.5	50	110	72.8	0.4	7.8
Junc 8	10	62.4	124.8	50.4	40.4	Pipe 9	282.3	250	110	1904.8	0.5	1.3
Junc 9	10	46.4	92.8	50.3	40.3	Pipe 10	105.9	200	110	906.1	0.3	1.0
Junc 10	10	36.4	72.8	50.1	40.1	Pipe 11	298.4	200	110	667.7	0.3	0.6
Junc 11	10	36.4	72.8	50.0	40.0	Pipe 12	314.9	200	110	594.9	0.2	0.4
Junc 12	10	36.4	72.8	49.8	39.8	Pipe 13	490.6	200	110	522.1	0.2	0.4
Junc 13	10	36.4	72.8	49.7	39.7	Pipe 14	396.2	200	110	449.3	0.2	0.3
Junc 14	15	36.4	72.8	49.6	34.6	Pipe 15	329.8	200	110	376.5	0.1	0.2
Junc 15	15	36.4	72.8	49.4	34.4	Pipe 16	427.6	150	110	303.7	0.2	0.5
Junc 16	20	36.4	72.8	49.3	29.3	Pipe 17	382.7	150	110	230.9	0.2	0.3
Junc 17	10	36.4	72.8	48.7	38.7	Pipe 18	490.5	100	110	158.1	0.2	1.1
Junc 18	10	36.4	72.8	48.5	38.5	Pipe 19	529.3	100	110	85.3	0.1	0.4
Junc 19	10	36.4	72.8	48.5	38.5	Pipe 20	237.7	100	110	12.5	0.0	0.0
Junc 20	10	36.4	72.8	48.6	38.6	Pipe 21	305.8	150	110	−205.9	0.1	0.3
Junc 21	10	36.4	72.8	48.8	38.8	Pipe 22	306.0	150	110	−278.7	0.2	0.4
Junc 22	10	36.4	72.8	48.9	38.9	Pipe 23	214.2	150	110	−351.5	0.2	0.7
Junc 23	10	36.4	72.8	49.5	39.5	Pipe 24	640.9	150	110	−424.3	0.3	1.0
Junc 24	10	36.4	72.8	50.1	40.1	Pipe 25	417.7	150	110	−497.1	0.3	1.3
Junc 25	10	36.4	72.8	50.1	40.1	Pipe 27	217.1	200	110	−569.9	0.2	0.4
Junc 26	10	36.4	72.8	49.8	39.8	Pipe 28	246.5	200	110	−642.7	0.2	0.5
Junc 27	10	36.4	72.8	49.5	39.5	Pipe 29	102.4	200	110	−873.9	0.3	0.9
Junc 28	10	36.4	72.8	47.9	37.9	Pipe 30	173.3	80	110	145.6	0.3	2.9
Junc 29	10	36.4	72.8	44.1	34.1	Pipe 31	316.3	80	110	72.8	0.2	0.8
Junc 30	10	42.8	85.6	50.3	40.3	Pipe 33	214.8	50	110	145.6	0.9	28.1
Junc 31	10	36.4	72.8	44.2	34.2	Pipe 34	164.1	50	110	72.8	0.4	7.8
Junc 32	10	36.4	72.8	43.0	33.0	Pipe 35	231.0	80	110	145.6	0.3	2.9
Junc 33	40	0.0	0.0	53.9	13.9	Pipe 36	485.1	50	110	72.8	0.4	7.8
Junc 34	10	10.4	20.8	49.5	39.5	Pipe 37	425.5	250	110	2050.4	0.5	1.5
Junc 35	40	20.0	40.0	47.2	7.2	Pipe 38	791.6	250	110	1977.6	0.5	1.4

(2) Location of junctions



(3) Location of links

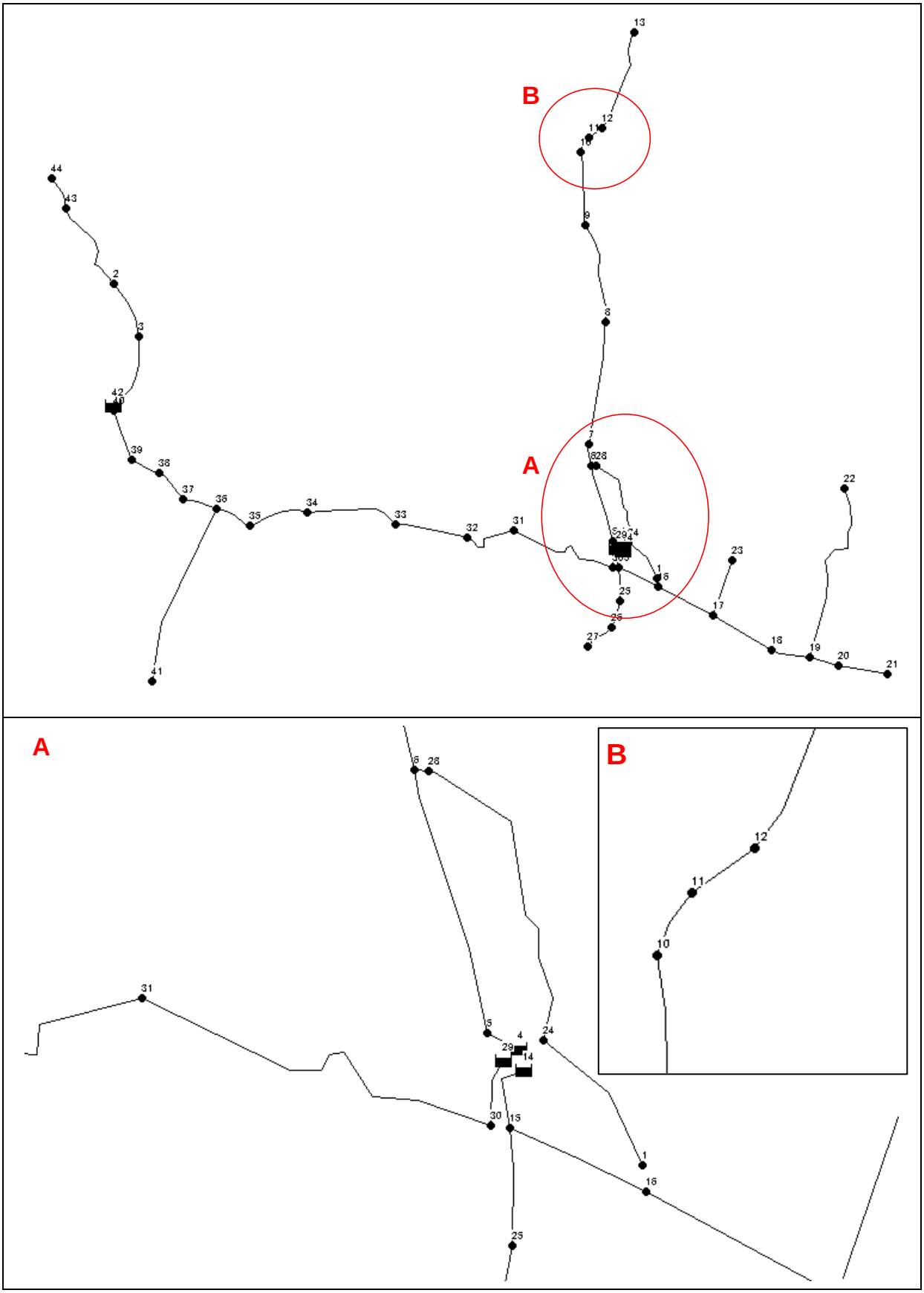


14.3 FPG-4

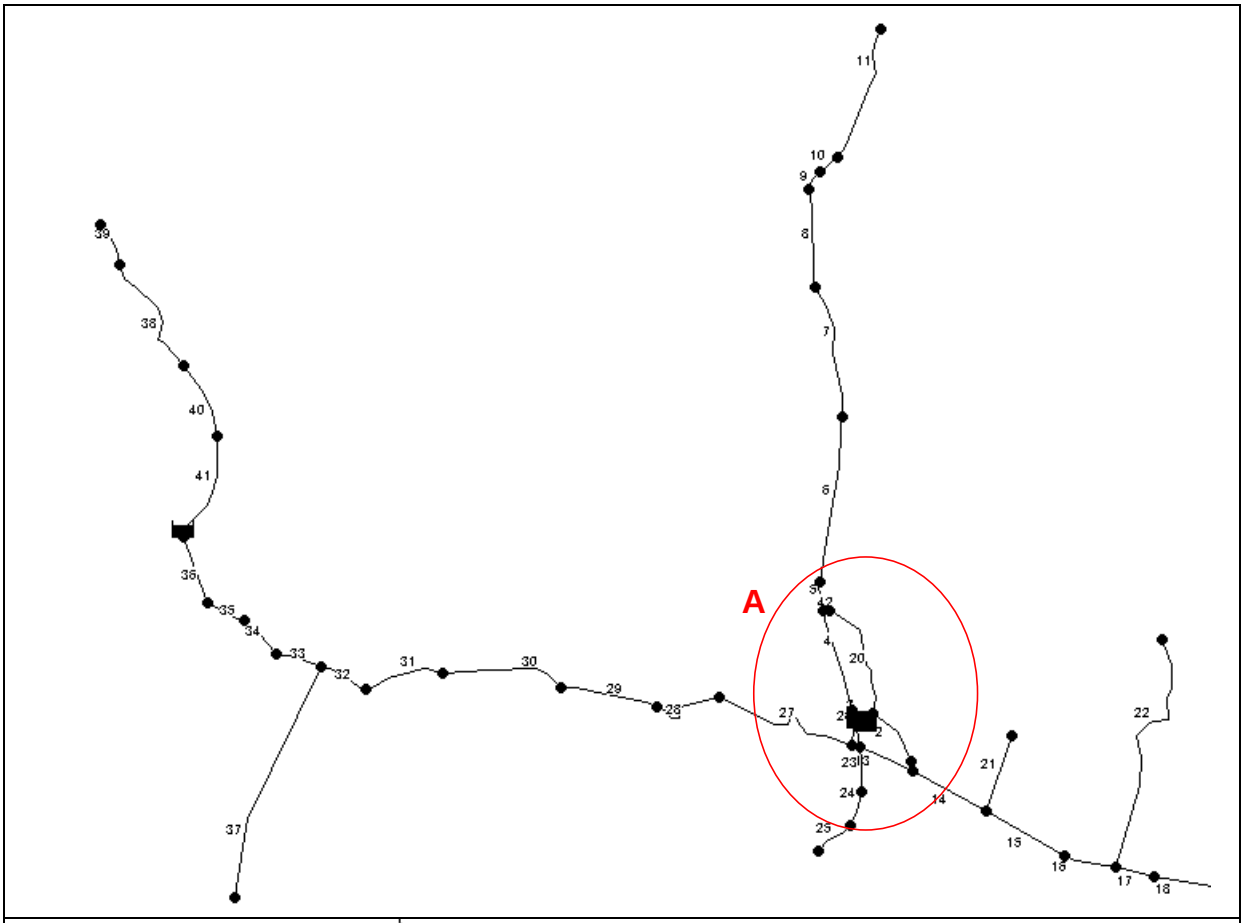
(1) Result of distribution network analysis

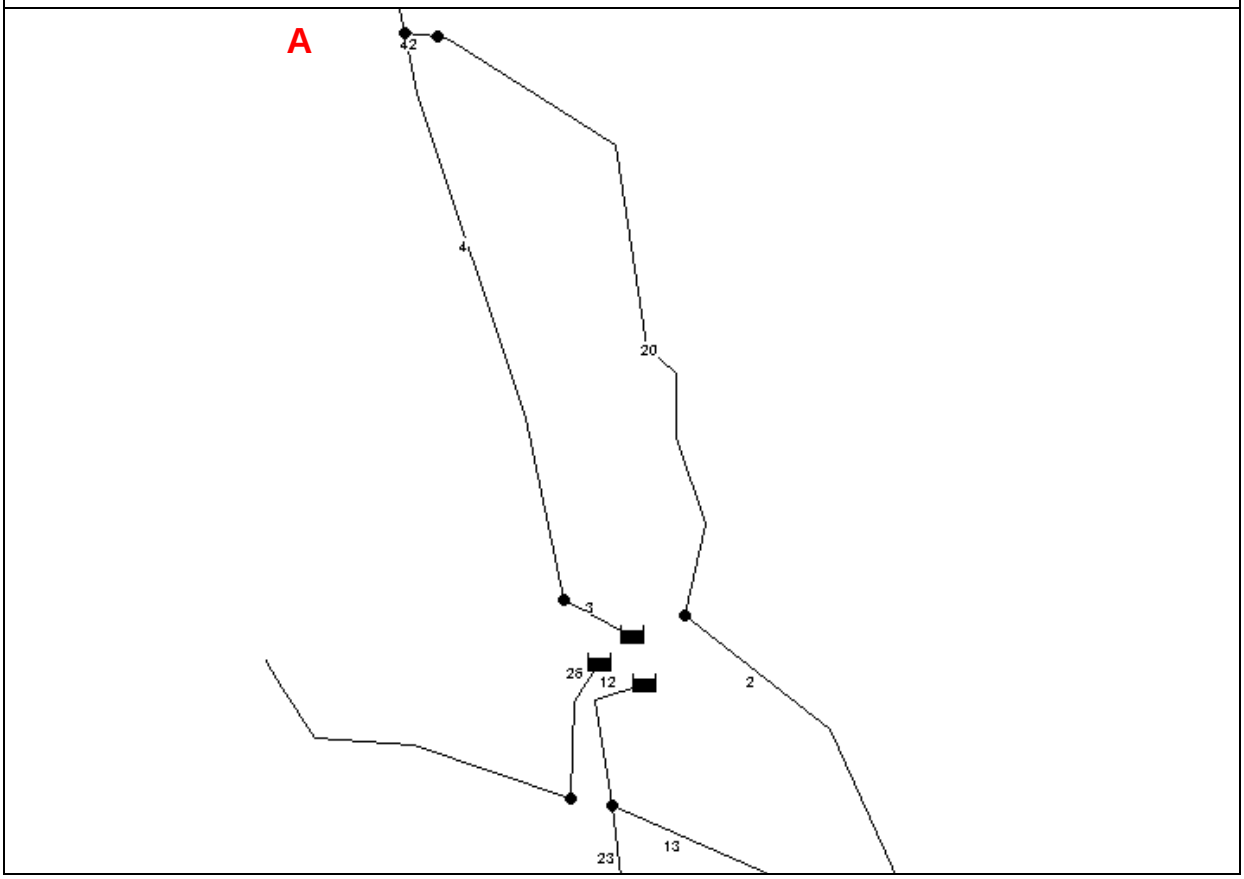
Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 4	215		−621.4	215.0	0.0	Pipe 3	173.3	150	110	621.4	0.4	2.0
Resvr 14	130		−960.0	130.0	0.0	Pipe 4	1352.5	150	110	601.4	0.4	1.8
Resvr 29	211		−468.6	211.0	0.0	Pipe 5	384.0	150	110	561.4	0.4	1.6
Resvr 42	240		−133.6	240.0	0.0	Pipe 6	2145.6	150	110	481.2	0.3	1.2
Junc 5	120	10.0	20.0	214.7	94.7	Pipe 7	1754.3	150	110	401.0	0.3	0.9
Junc 6	140	10.0	20.0	212.2	72.2	Pipe 8	1265.9	150	110	320.8	0.2	0.6
Junc 7	140	40.1	80.2	211.6	71.6	Pipe 9	282.5	150	110	240.6	0.2	0.3
Junc 8	140	40.1	80.2	208.9	68.9	Pipe 10	297.4	150	110	160.4	0.1	0.2
Junc 9	140	40.1	80.2	207.4	67.4	Pipe 11	1786.1	150	110	80.2	0.1	0.0
Junc 10	160	40.1	80.2	206.7	46.7	Pipe 12	361.4	200	110	960.0	0.4	1.1
Junc 11	160	40.1	80.2	206.6	46.6	Pipe 13	748.6	200	110	640.0	0.2	0.5
Junc 12	150	40.1	80.2	206.5	56.5	Pipe 14	1082.6	200	110	560.0	0.2	0.4
Junc 13	170	40.1	80.2	206.5	36.5	Pipe 15	1189.4	200	110	400.0	0.2	0.2
Junc 15	120	40.0	80.0	129.6	9.6	Pipe 16	667.9	200	110	320.0	0.1	0.1
Junc 16	120	40.0	80.0	129.2	9.2	Pipe 17	528.2	200	110	160.0	0.1	0.0
Junc 17	100	40.0	80.0	128.8	28.8	Pipe 18	869.5	200	110	80.0	0.0	0.0
Junc 18	90	40.0	80.0	128.6	38.6	Pipe 20	1610.8	50	110	−20.0	0.1	0.7
Junc 19	80	40.0	80.0	128.5	48.5	Pipe 21	1023.2	50	110	80.0	0.5	9.3
Junc 20	80	40.0	80.0	128.4	48.4	Pipe 22	3295.2	50	110	80.0	0.5	9.3
Junc 21	70	40.0	80.0	128.4	58.4	Pipe 23	581.9	100	110	240.0	0.4	2.4
Junc 22	60	40.0	80.0	97.9	37.9	Pipe 24	474.3	100	110	160.0	0.2	1.1
Junc 23	90	40.0	80.0	119.3	29.3	Pipe 25	540.4	100	110	80.0	0.1	0.3
Junc 24	130	5.0	10.0	211.0	81.0	Pipe 26	326.9	150	110	468.6	0.3	1.2
Junc 25	110	40.0	80.0	128.2	18.2	Pipe 27	2008.4	150	110	388.6	0.3	0.8
Junc 26	100	40.0	80.0	127.7	27.7	Pipe 28	1022.5	150	110	308.6	0.2	0.5
Junc 27	100	40.0	80.0	127.5	27.5	Pipe 29	1272.8	150	110	308.6	0.2	0.5
Junc 28	140	0.0	0.0	212.1	72.1	Pipe 30	1632.8	150	110	278.4	0.2	0.4
Junc 30	120	40.0	80.0	210.6	90.6	Pipe 31	1059.2	150	110	248.2	0.2	0.4
Junc 31	120	40.0	80.0	209.0	89.0	Pipe 32	670.0	150	110	218.0	0.1	0.3
Junc 32	110	0.0	0.0	208.4	98.4	Pipe 33	613.2	150	110	177.8	0.1	0.2
Junc 33	130	15.1	30.2	207.7	77.7	Pipe 34	604.7	150	110	147.6	0.1	0.1
Junc 34	160	15.1	30.2	207.0	47.0	Pipe 35	541.1	150	110	97.2	0.1	0.1
Junc 35	160	15.1	30.2	206.6	46.6	Pipe 36	909.7	150	110	67.0	0.0	0.0
Junc 36	160	15.1	30.2	206.5	46.5	Pipe 37	3217.6	50	110	10.0	0.1	0.2
Junc 37	160	15.1	30.2	206.3	46.3	Pipe 39	588.8	50	110	33.4	0.2	1.8
Junc 38	160	25.2	50.4	206.3	46.3	Pipe 2	1000.0	50	110	10.0	0.1	0.2
Junc 39	180	15.1	30.2	206.2	26.2	Pipe 38	1674.5	50	110	−66.8	0.4	6.6
Junc 40	189	33.5	67.0	206.2	17.2	Pipe 40	1026.4	65	110	−100.2	0.4	3.9
Junc 41	200	5.0	10.0	205.8	5.8	Pipe 41	1384.4	65	110	−133.6	0.5	6.7
Junc 43	160	16.7	33.4	215.6	55.6	Pipe 42	76.4	50	110	20.0	0.1	0.7
Junc 44	160	16.7	33.4	214.6	54.6							
Junc 1	120	5.0	10.0	210.8	90.8							
Junc 2	220	16.7	33.4	226.7	6.7							
Junc 3	220	16.7	33.4	230.8	10.8							

(2) Location of junctions



(3) Location of links



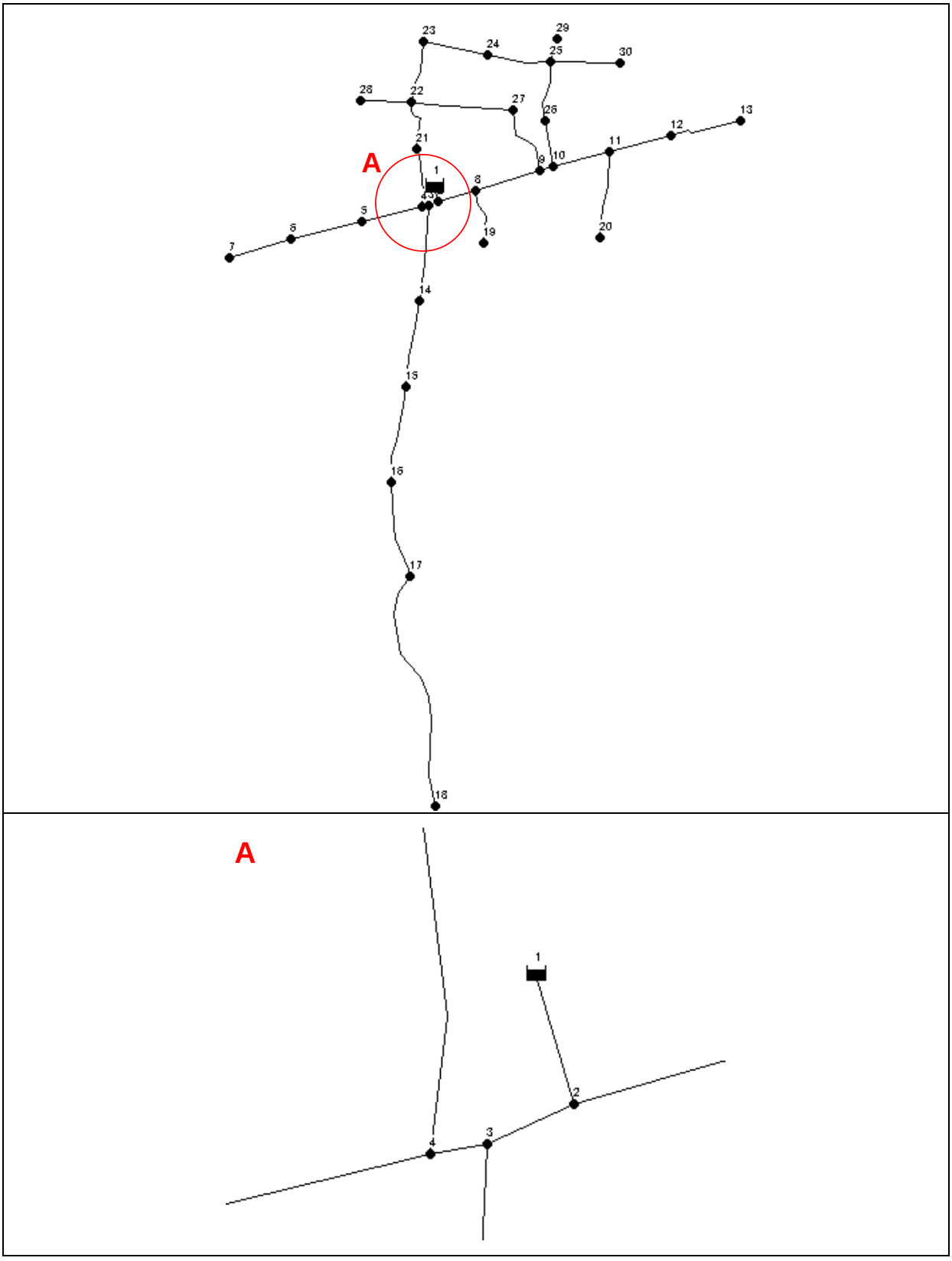


14.4 FPS-5

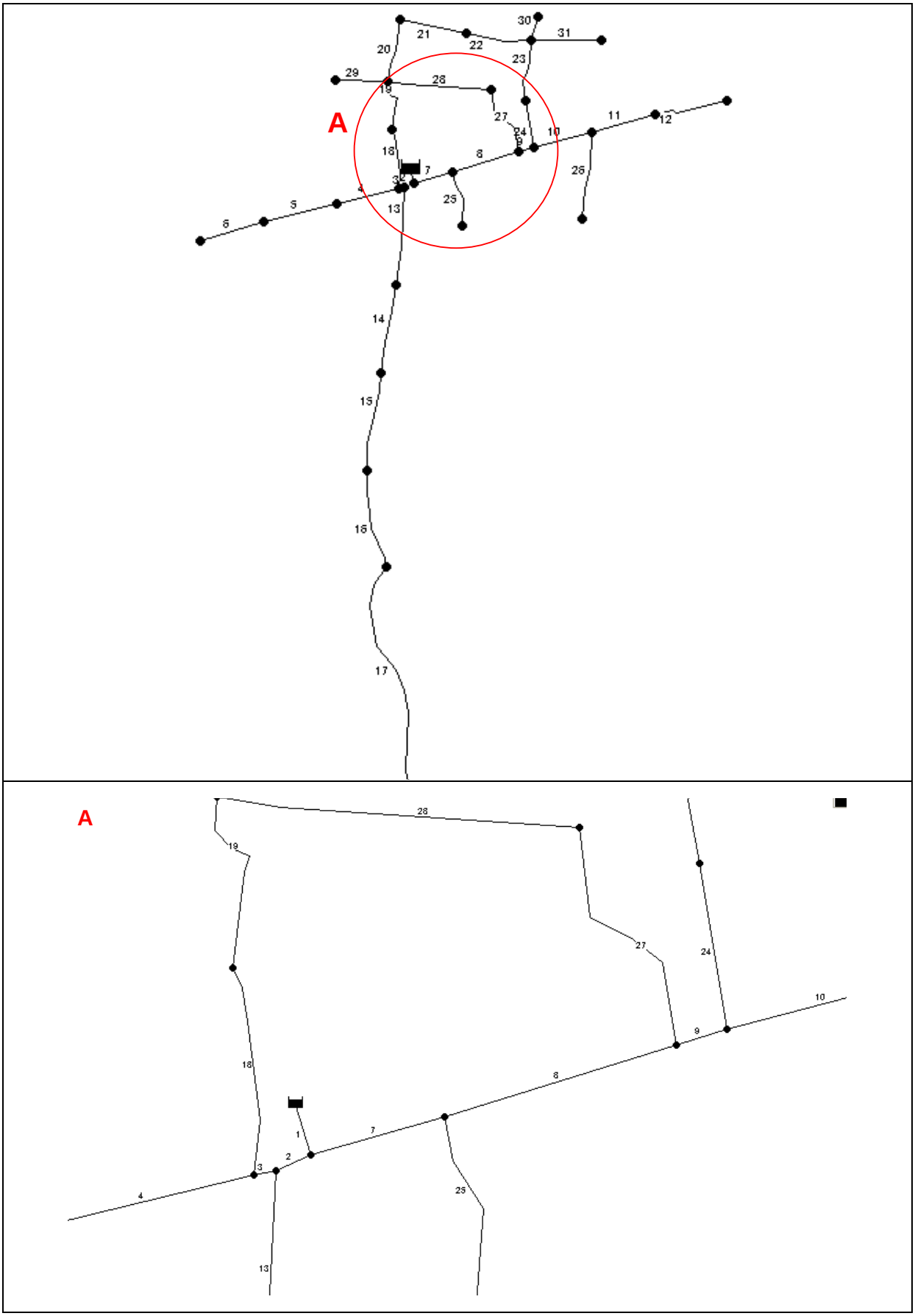
(1) Result of distribution network analysis

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	68		−1560.2	68.0	0.0	Pipe 1	113.4	200	110	1560.2	0.6	2.7
Junc 2	55	26.9	53.8	67.7	12.7	Pipe 2	79.7	150	110	632.6	0.4	2.0
Junc 3	55	26.9	53.8	67.5	12.5	Pipe 3	48.0	150	110	538.8	0.4	1.5
Junc 4	55	26.9	53.8	67.5	12.5	Pipe 4	469.8	150	110	161.4	0.1	0.2
Junc 5	60	26.9	53.8	67.4	7.4	Pipe 5	550.8	150	110	107.6	0.1	0.1
Junc 6	60	26.9	53.8	67.4	7.4	Pipe 6	493.1	150	110	53.8	0.0	0.0
Junc 7	60	26.9	53.8	67.3	7.3	Pipe 7	295.1	150	110	873.8	0.6	3.7
Junc 8	54	43.8	87.6	66.6	12.6	Pipe 8	509.7	150	110	732.4	0.5	2.7
Junc 9	53	43.8	87.6	65.3	12.3	Pipe 9	110.9	150	110	551.9	0.4	1.6
Junc 10	52	26.9	53.8	65.1	13.1	Pipe 10	440.1	150	110	269.0	0.2	0.4
Junc 11	52	53.8	107.6	64.9	12.9	Pipe 11	484.7	150	110	107.6	0.1	0.1
Junc 12	45	26.9	53.8	64.9	19.9	Pipe 12	548.0	150	110	53.8	0.0	0.0
Junc 13	45	26.9	53.8	64.9	19.9	Pipe 13	724.9	50	110	40.0	0.2	2.6
Junc 14	45	0.0	0.0	65.7	20.7	Pipe 14	652.3	50	110	40.0	0.2	2.6
Junc 15	45	10.0	20.0	64.0	19.0	Pipe 15	735.6	50	110	20.0	0.1	0.7
Junc 16	35	0.0	0.0	63.5	28.5	Pipe 16	737.6	50	110	20.0	0.1	0.7
Junc 17	35	0.0	0.0	63.0	28.0	Pipe 17	1843.4	50	110	20.0	0.1	0.7
Junc 18	35	10.0	20.0	61.7	26.7	Pipe 18	443.5	100	110	323.6	0.5	4.2
Junc 19	50	26.9	53.8	64.8	14.8	Pipe 19	400.2	100	110	269.8	0.4	3.0
Junc 20	50	26.9	53.8	62.0	12.0	Pipe 20	465.9	100	110	147.5	0.2	1.0
Junc 21	55	26.9	53.8	65.6	10.6	Pipe 21	495.6	100	110	93.7	0.1	0.4
Junc 22	53	53.8	107.6	64.4	11.4	Pipe 22	481.6	100	110	39.9	0.1	0.1
Junc 23	50	26.9	53.8	63.9	13.9	Pipe 23	456.2	100	110	−175.3	0.3	1.4
Junc 24	50	26.9	53.8	63.7	13.7	Pipe 24	353.0	100	110	−229.1	0.3	2.2
Junc 25	45	53.8	107.6	63.7	18.7	Pipe 25	419.0	50	110	53.8	0.3	4.4
Junc 26	50	26.9	53.8	64.3	14.3	Pipe 26	650.1	50	110	53.8	0.3	4.4
Junc 27	50	26.9	53.8	64.6	14.6	Pipe 27	545.4	80	110	92.9	0.2	1.2
Junc 28	50	26.9	53.8	62.7	12.7	Pipe 28	767.0	80	110	39.1	0.1	0.3
Junc 29	40	26.9	53.8	62.9	22.9	Pipe 29	390.1	50	110	53.8	0.3	4.4
Junc 30	43	26.9	53.8	61.4	18.4	Pipe 30	177.6	50	110	53.8	0.3	4.4
						Pipe 31	523.6	50	110	53.8	0.3	4.4

(2) Location of junctions



(3) Location of links

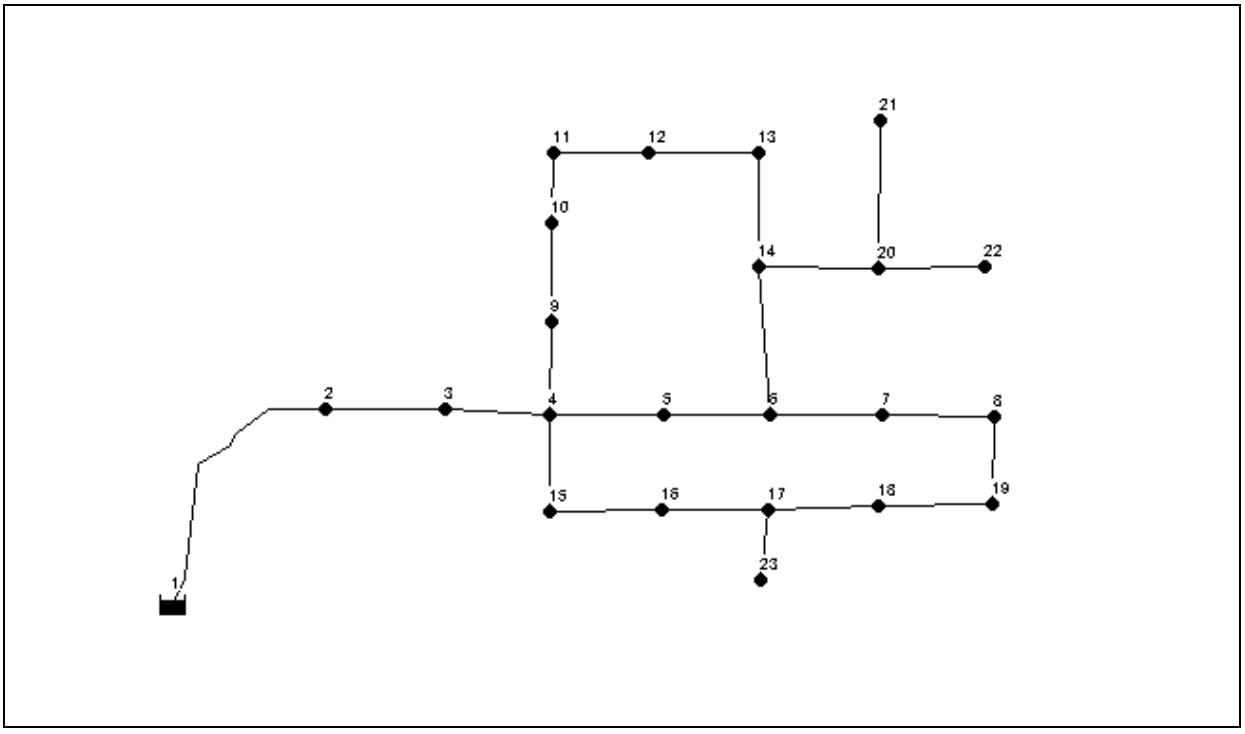


14.5 FKS-6

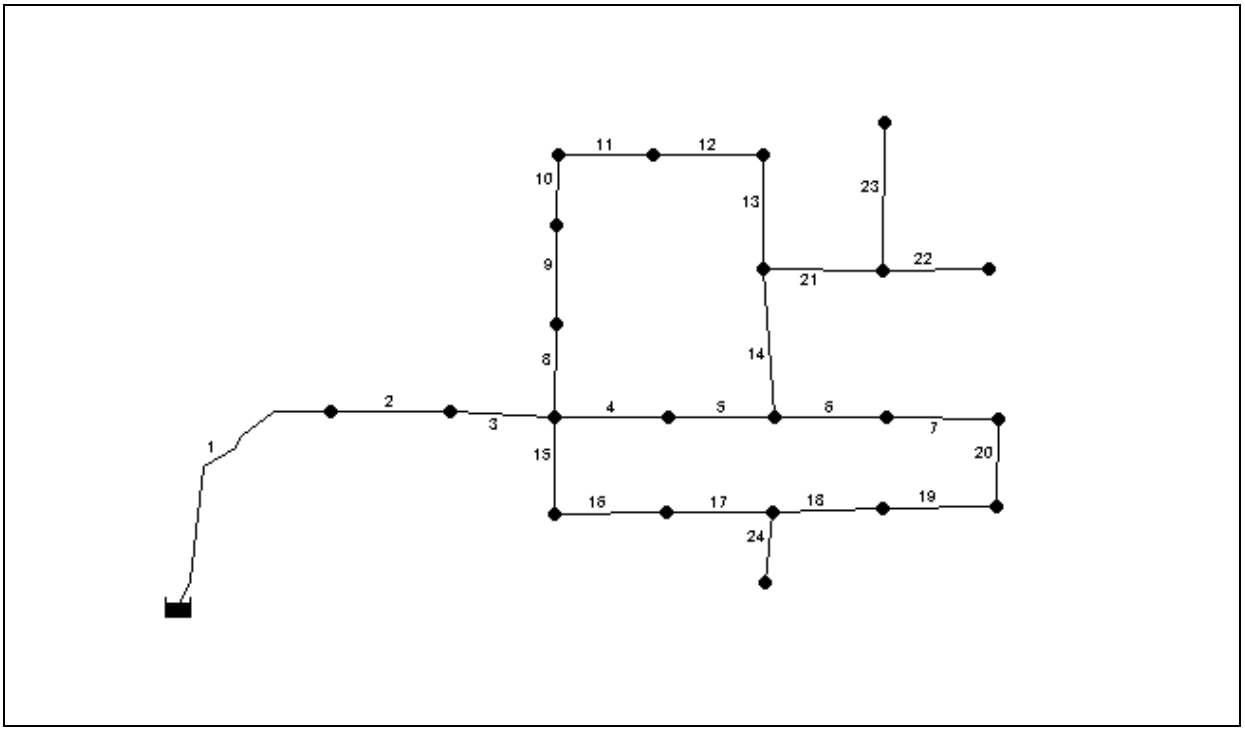
(1) Result of distribution network analysis

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	89		−1166	89.0	0.0	Pipe 1	847.4	200	110	1166.0	0.4	1.6
Junc 2	60	26.5	53	87.7	27.7	Pipe 2	347.1	200	110	1113.0	0.4	1.4
Junc 3	60	26.5	53	87.2	27.2	Pipe 3	304.8	200	110	1060.0	0.4	1.3
Junc 4	60	26.5	53	86.8	26.8	Pipe 4	331.1	200	110	593.8	0.2	0.4
Junc 5	60	26.5	53	86.7	26.7	Pipe 5	309.7	200	110	540.8	0.2	0.4
Junc 6	55	26.5	53	86.5	31.5	Pipe 6	325.7	200	110	248.1	0.1	0.1
Junc 7	55	26.5	53	86.5	31.5	Pipe 7	325.8	200	110	195.1	0.1	0.1
Junc 8	55	26.5	53	86.5	31.5	Pipe 8	272.4	100	110	237.2	0.4	2.4
Junc 9	60	26.5	53	86.2	26.2	Pipe 9	286.6	100	110	184.2	0.3	1.5
Junc 10	55	26.5	53	85.7	30.7	Pipe 10	199.4	100	110	131.2	0.2	0.8
Junc 11	55	26.5	53	85.6	30.6	Pipe 11	277.7	100	110	78.2	0.1	0.3
Junc 12	55	26.5	53	85.5	30.5	Pipe 12	320.4	100	110	25.2	0.0	0.0
Junc 13	55	26.5	53	85.5	30.5	Pipe 13	325.7	100	110	−27.8	0.0	0.0
Junc 14	55	26.5	53	85.5	30.5	Pipe 14	433.7	100	110	−239.8	0.4	2.4
Junc 15	65	26.5	53	86.4	21.4	Pipe 15	283.0	100	110	175.9	0.3	1.4
Junc 16	65	26.5	53	86.2	21.2	Pipe 16	325.8	100	110	122.9	0.2	0.7
Junc 17	60	26.5	53	86.1	26.1	Pipe 17	309.7	100	110	69.9	0.1	0.3
Junc 18	55	26.5	53	86.1	31.1	Pipe 18	320.6	100	110	−36.1	0.1	0.1
Junc 19	50	26.5	53	86.3	36.3	Pipe 19	331.2	100	110	−89.1	0.1	0.4
Junc 20	55	26.5	53	82.3	27.3	Pipe 20	251.0	100	110	−142.1	0.2	0.9
Junc 21	55	26.5	53	80.5	25.5	Pipe 21	347.1	65	110	159.0	0.6	9.2
Junc 22	50	26.5	53	81.0	31.0	Pipe 22	309.8	50	110	53.0	0.3	4.3
Junc 23	60	26.5	53	85.2	25.2	Pipe 23	427.2	50	110	53.0	0.3	4.3
						Pipe 24	204.6	50	110	53.0	0.3	4.3

(2) Location of junctions



(3) Location of links

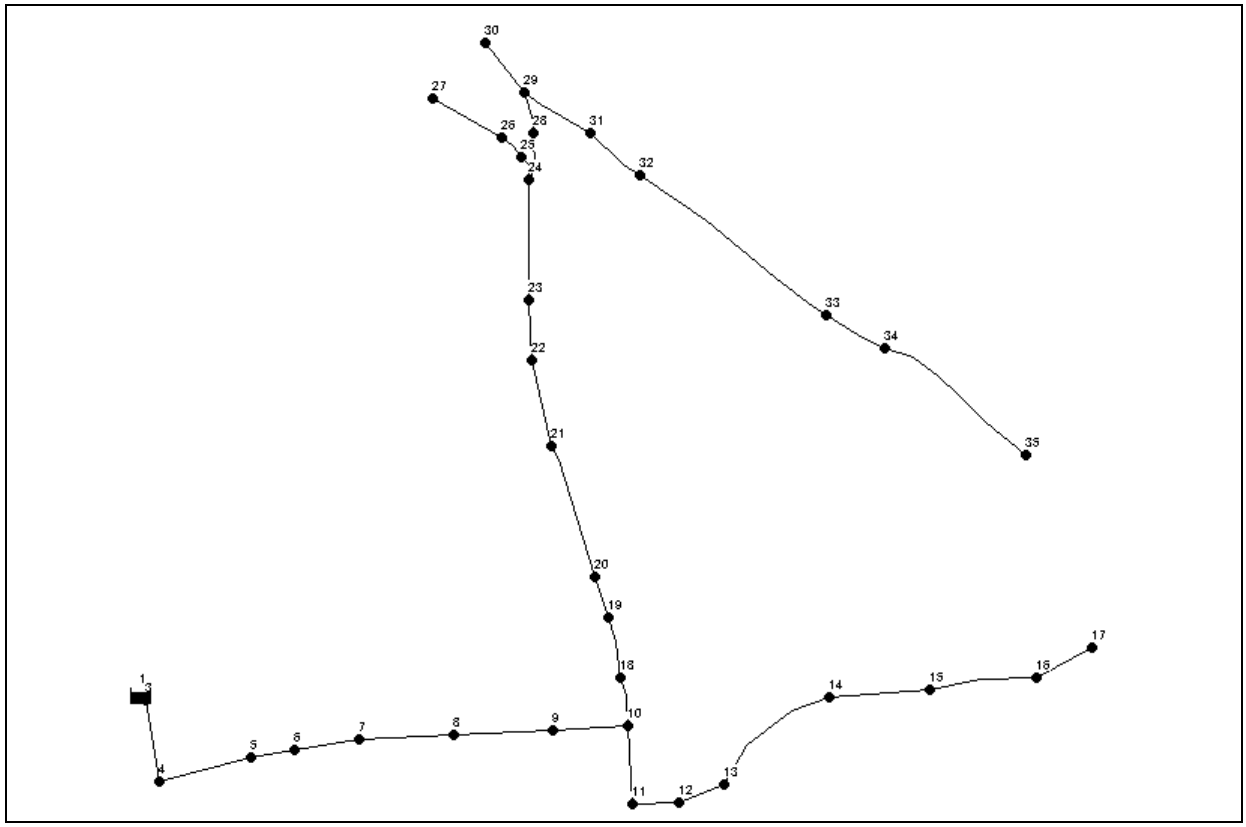


14.6 FKS-8

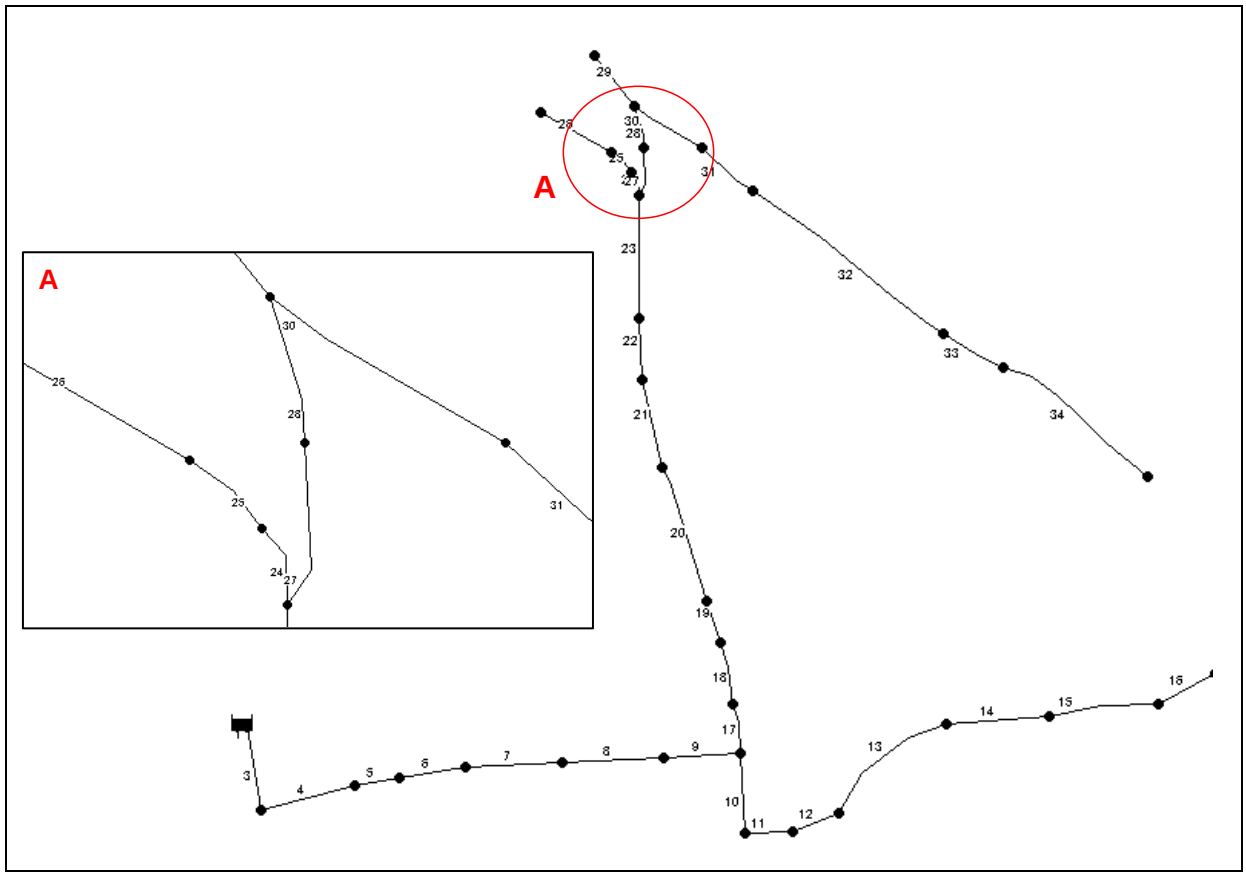
(1) Result of distribution network analysis

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	49		−1250.0	49.0	0.0	Pipe 3	402.0	200	110	1212.2	0.5	1.7
Junc 3	29	18.9	37.9	48.9	19.9	Pipe 4	435.0	200	110	1174.3	0.4	1.6
Junc 4	28	18.9	37.9	48.3	20.3	Pipe 5	202.0	200	110	1136.4	0.4	1.5
Junc 5	27	18.9	37.9	47.6	20.6	Pipe 6	303.1	200	110	1098.5	0.4	1.4
Junc 6	27	18.9	37.9	47.3	20.3	Pipe 7	437.9	200	110	1060.6	0.4	1.3
Junc 7	26	18.9	37.9	46.9	20.9	Pipe 8	459.8	200	110	1022.8	0.4	1.2
Junc 8	26	18.9	37.9	46.3	20.3	Pipe 9	349.5	200	110	984.9	0.4	1.1
Junc 9	25	18.9	37.9	45.8	20.8	Pipe 10	360.2	100	110	228.9	0.3	2.2
Junc 10	22	37.9	75.8	45.4	23.4	Pipe 11	216.2	100	110	191.1	0.3	1.6
Junc 11	22	18.9	37.9	44.6	22.6	Pipe 12	226.2	100	110	153.2	0.2	1.1
Junc 12	22	18.9	37.9	44.2	22.2	Pipe 13	653.1	50	110	115.3	0.7	18.2
Junc 13	22	18.9	37.9	44.0	22.0	Pipe 14	460.7	50	110	96.4	0.6	13.1
Junc 14	22	9.5	18.9	32.1	10.1	Pipe 15	503.4	50	110	75.8	0.5	8.4
Junc 15	19	9.5	18.9	26.1	7.1	Pipe 16	289.8	50	110	37.9	0.2	2.3
Junc 16	10	18.9	37.9	21.8	11.8	Pipe 17	231.3	150	110	680.2	0.5	2.3
Junc 17	5	18.9	37.9	21.2	16.2	Pipe 18	278.9	150	110	642.3	0.4	2.1
Junc 18	22	18.9	37.9	44.8	22.8	Pipe 19	203.1	150	110	604.4	0.4	1.9
Junc 19	20	18.9	37.9	44.2	24.2	Pipe 20	636.5	150	110	566.5	0.4	1.7
Junc 20	20	18.9	37.9	43.9	23.9	Pipe 21	404.2	150	110	528.7	0.4	1.5
Junc 21	22	18.9	37.9	42.8	20.8	Pipe 22	277.0	150	110	490.8	0.3	1.3
Junc 22	23	18.9	37.9	42.2	19.2	Pipe 23	559.1	150	110	452.9	0.3	1.1
Junc 23	20	18.9	37.9	41.9	21.9	Pipe 24	110.9	50	110	113.6	0.7	17.8
Junc 24	10	18.9	37.9	41.3	31.3	Pipe 25	130.7	50	110	75.8	0.5	8.4
Junc 25	10	18.9	37.9	39.3	29.3	Pipe 26	364.6	50	110	37.9	0.2	2.3
Junc 26	10	18.9	37.9	38.2	28.2	Pipe 27	220.0	100	110	301.4	0.4	3.7
Junc 27	10	18.9	37.9	37.4	27.4	Pipe 28	194.6	100	110	263.5	0.4	2.9
Junc 28	7	18.9	37.9	40.5	33.5	Pipe 29	291.4	50	110	37.9	0.2	2.3
Junc 29	7	18.9	37.9	39.9	32.9	Pipe 30	358.4	100	110	187.7	0.3	1.5
Junc 30	7	18.9	37.9	39.2	32.2	Pipe 31	303.4	100	110	149.9	0.2	1.0
Junc 31	5	18.9	37.9	39.4	34.4	Pipe 32	1072.8	50	110	112.0	0.7	17.3
Junc 32	5	18.9	37.9	39.0	34.0	Pipe 33	313.1	50	110	74.1	0.4	8.0
Junc 33	5	18.9	37.9	20.5	15.5	Pipe 34	829.4	50	110	36.2	0.2	2.1
Junc 34	5	18.9	37.9	18.0	13.0	Pipe 1	31.7	200	110	1250.0	0.5	1.8
Junc 35	5	18.9	37.9	16.2	11.2	Pipe 2	1336.81	12	100	−1.66	0.17	7.35

(2) Location of junctions



(3) Location of links



14.7 FNG-10

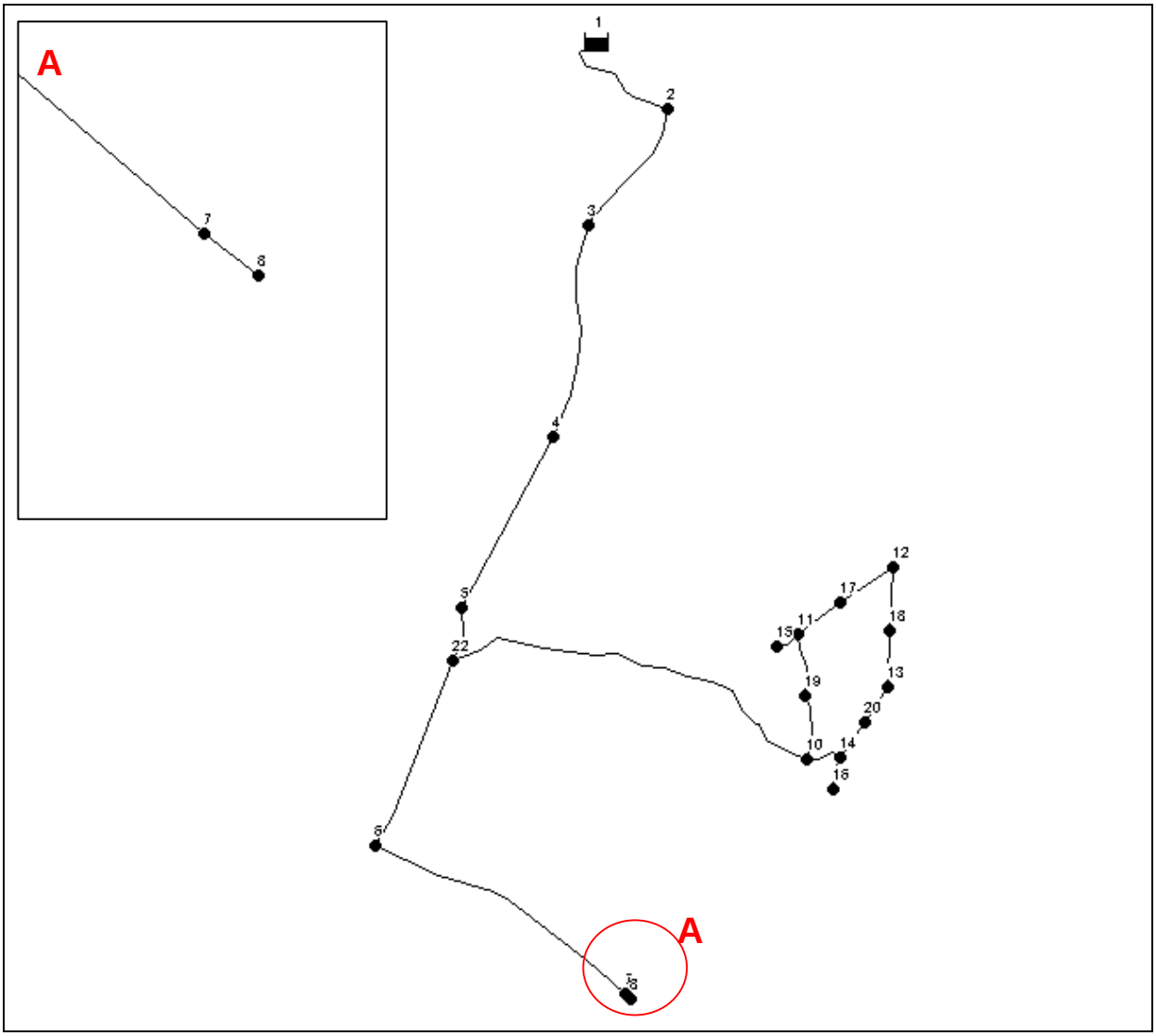
(1) Result of distribution network analysis - 1

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	84		-3989.6	84.0	0.0	Pipe 1	1728.0	300	110	3989.6	0.7	2.1
Junc 2	10	0.0	0.0	80.4	70.4	Pipe 2	1941.8	300	110	3989.6	0.7	2.1
Junc 3	15	0.0	0.0	76.3	61.3	Pipe 3	2940.8	300	110	3989.6	0.7	2.1
Junc 4	20	0.0	0.0	70.2	50.2	Pipe 4	2604.8	300	110	3989.6	0.7	2.1
Junc 5	15	0.0	0.0	64.7	49.7	Pipe 6	3966.1	200	110	1168.0	0.4	1.6
Junc 6	20	0.0	0.0	59.0	39.0	Pipe 7	102.6	250	110	1168.0	0.3	0.5
Junc 7	50	0.0	0.0	52.8	2.8	Pipe 10	889.9	200	110	1143.5	0.4	1.5
Junc 8	50	584.0	1168.0	52.8	2.8	Pipe 11	826.0	200	110	841.1	0.3	0.8
Junc 10	10	151.2	302.4	48.8	38.8	Pipe 12	712.7	150	110	488.7	0.3	1.3
Junc 11	10	151.2	302.4	46.7	36.7	Pipe 13	841.2	150	110	186.3	0.1	0.2
Junc 12	10	151.2	302.4	45.7	35.7	Pipe 14	855.3	150	110	-116.1	0.1	0.1
Junc 13	10	151.2	302.4	46.5	36.5	Pipe 15	765.4	150	110	-418.5	0.3	0.9
Junc 14	10	151.2	302.4	47.5	37.5	Pipe 16	564.0	200	110	-720.9	0.3	0.6
Junc 15	10	25.0	50.0	45.4	35.4	Pipe 17	574.3	200	110	-1023.3	0.4	1.2
Junc 16	10	25.0	50.0	45.8	35.8	Pipe 18	496.7	200	100	-1375.7	0.5	2.5
Junc 17	10	151.2	302.4	45.8	35.8	Pipe 19	354.3	50	110	50.0	0.3	3.9
Junc 18	10	151.2	302.4	45.7	35.7	Pipe 20	441.1	50	110	50.0	0.3	3.9
Junc 19	10	151.2	302.4	47.4	37.4	Pipe 5	732.9	300	110	3989.6	0.7	2.1
Junc 20	10	151.2	302.4	46.8	36.8	Pipe 8	2719.0	200	110	1168.0	0.4	1.6
Junc 22	15	0.0	0.0	63.2	48.2	Pipe 23	5385.7	250	110	2821.6	0.7	2.7

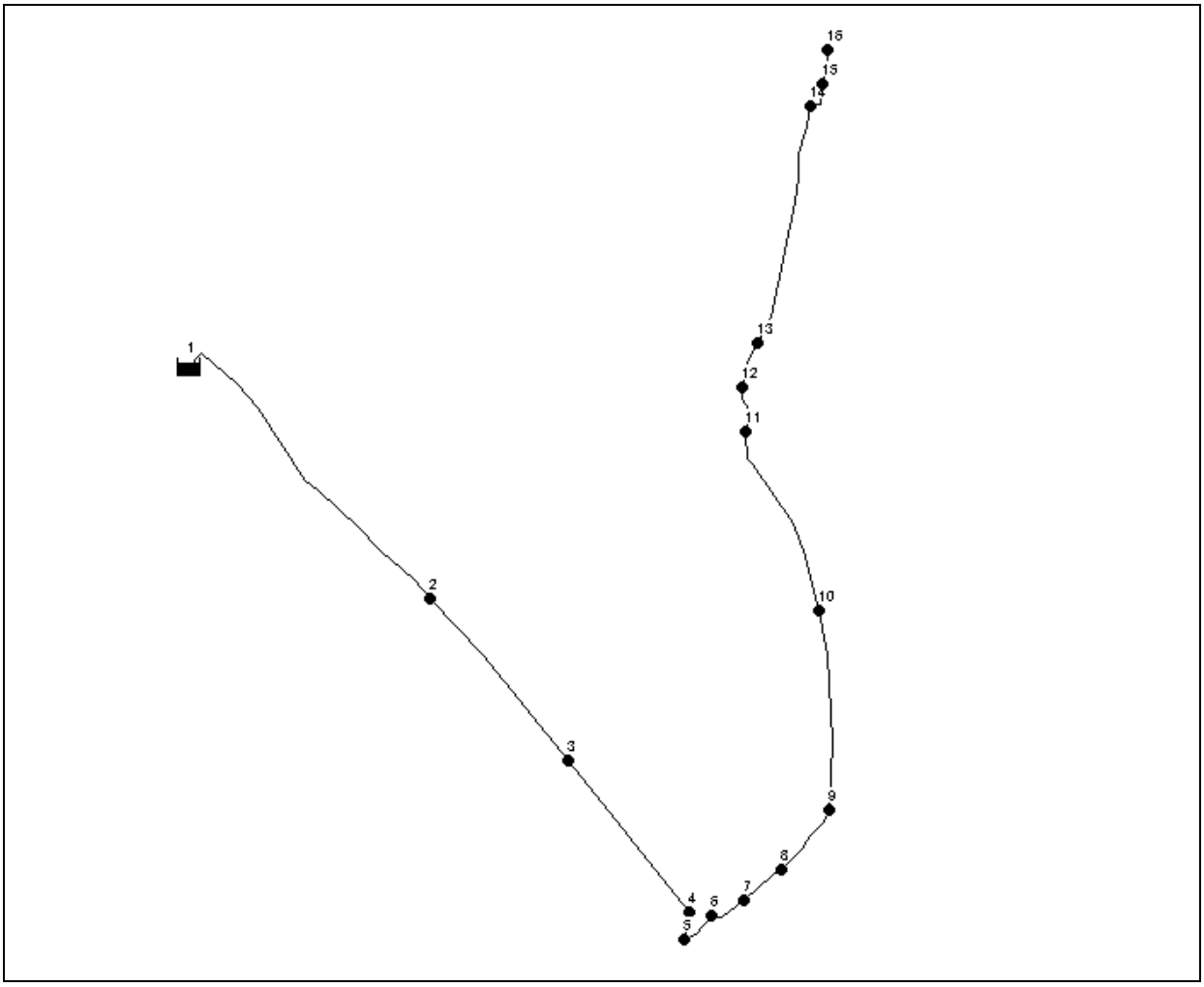
(2) Result of distribution network analysis - 2

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	124		-2312.4	124.0	0.0	Pipe 12	2412.6	250	110	2312.4	0.6	1.9
Junc 2	80	10.0	20.0	119.5	39.5	Pipe 13	1430.8	250	110	2292.4	0.5	1.8
Junc 3	70	10.0	20.0	116.9	46.9	Pipe 14	1310.5	250	110	2272.4	0.5	1.8
Junc 4	10	87.4	174.8	114.6	104.6	Pipe 15	188.0	250	110	2097.6	0.5	1.6
Junc 5	10	87.4	174.8	114.3	104.3	Pipe 16	256.9	250	110	1922.8	0.5	1.3
Junc 6	10	87.4	174.8	113.9	103.9	Pipe 17	267.3	250	110	1748.0	0.4	1.1
Junc 7	10	87.4	174.8	113.7	103.7	Pipe 18	319.1	250	110	1573.2	0.4	0.9
Junc 8	10	87.4	174.8	113.4	103.4	Pipe 19	524.3	150	110	1398.4	0.9	8.8
Junc 9	10	87.4	174.8	108.8	98.8	Pipe 20	1355.2	150	110	1223.6	0.8	6.9
Junc 10	10	87.4	174.8	99.5	89.5	Pipe 21	1332.5	150	110	1048.8	0.7	5.2
Junc 11	10	87.4	174.8	92.6	82.6	Pipe 22	310.5	150	110	874.0	0.6	3.7
Junc 12	10	87.4	174.8	91.4	81.4	Pipe 23	320.4	150	110	699.2	0.5	2.4
Junc 13	10	87.4	174.8	90.7	80.7	Pipe 24	1640.6	125	110	524.4	0.5	3.5
Junc 14	10	87.4	174.8	85.0	75.0	Pipe 25	208.9	125	110	349.6	0.3	1.6
Junc 15	10	87.4	174.8	84.6	74.6	Pipe 26	235.2	125	110	174.8	0.2	0.5
Junc 16	10	87.4	174.8	84.5	74.5							

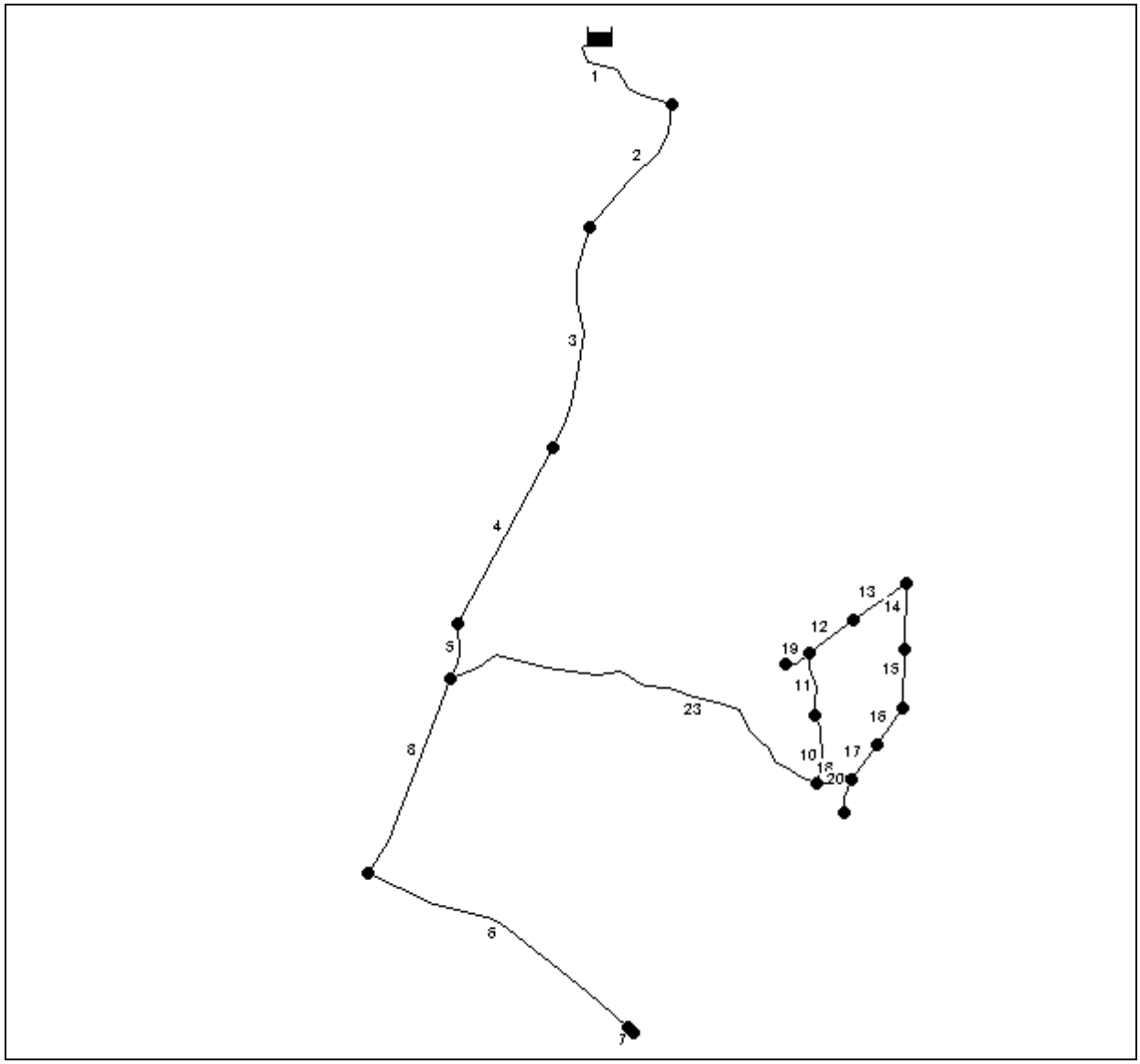
(2) Location of junctions - 1



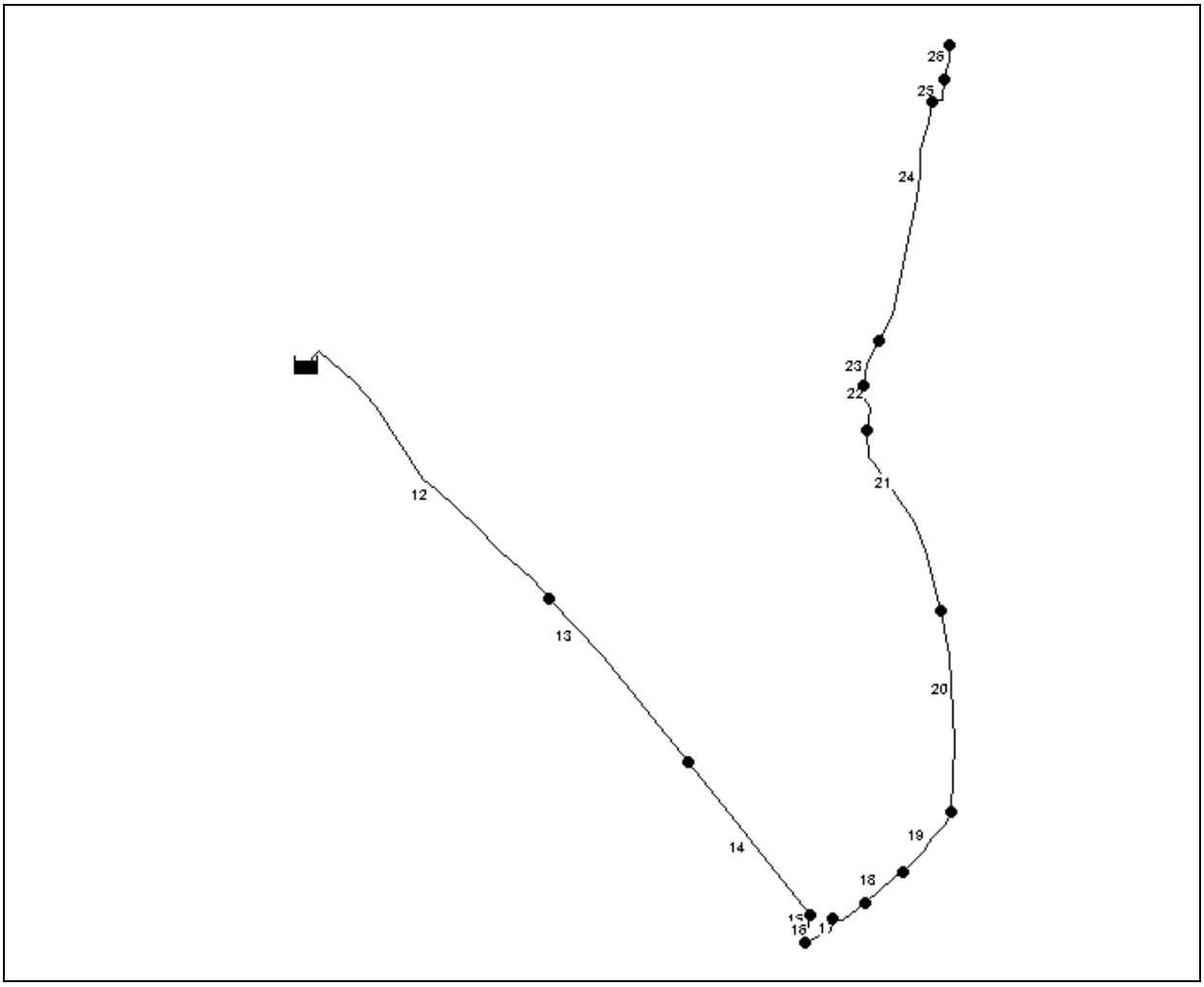
(2) Location of junctions – 2



(3) Location of links – 1



(3) Location of links – 2

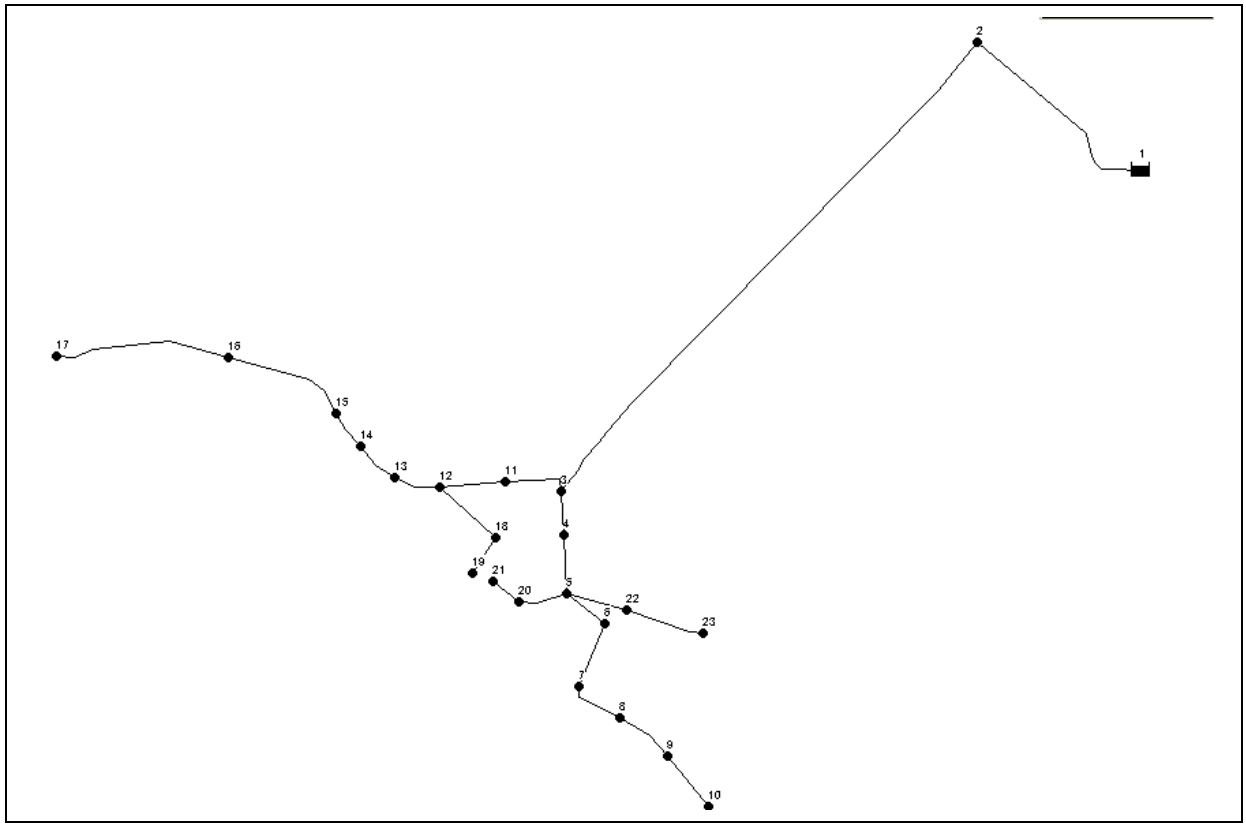


14.8 FBS-11

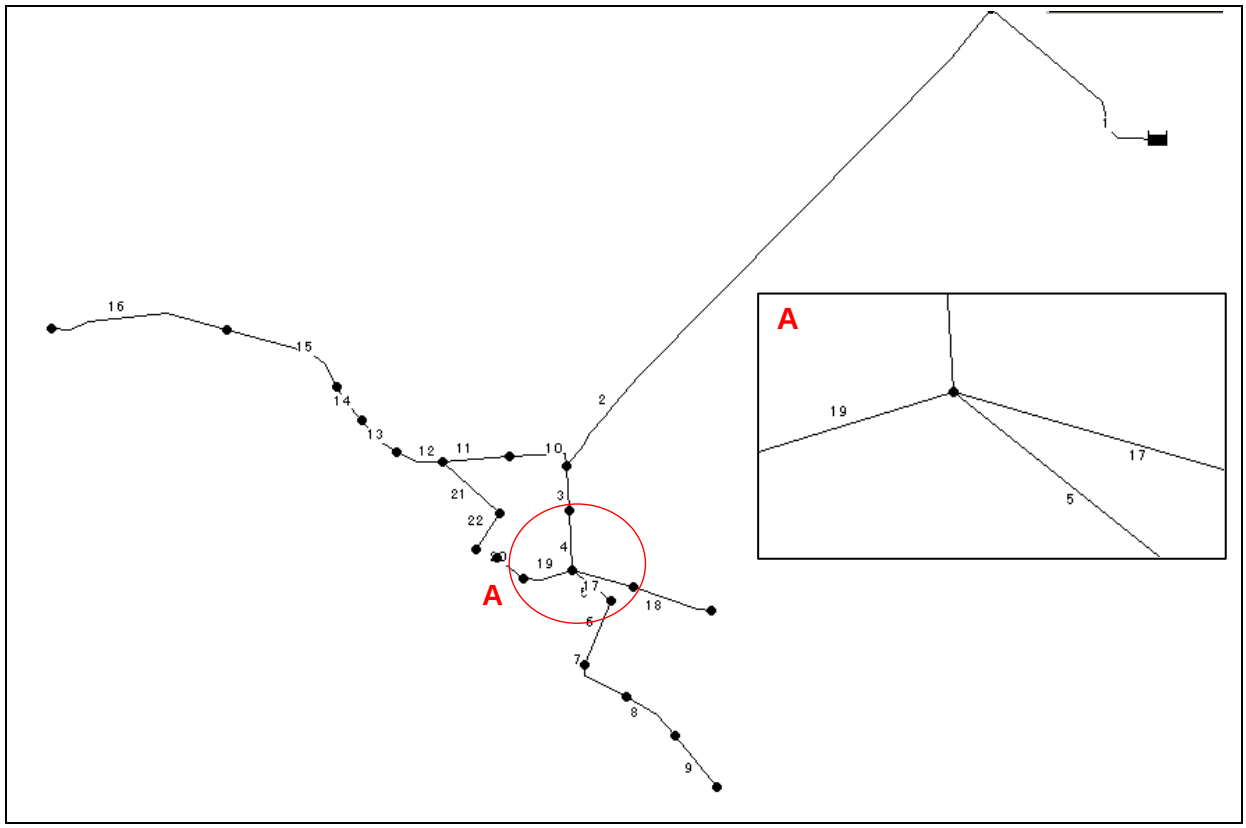
(1) Result of distribution network analysis

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	46		−1335.6	46	0	Pipe 1	1229.32	200	110	1335.6	0.49	1.99
Junc 2	20	0	0	43.56	23.56	Pipe 2	3414.9	200	110	1335.6	0.49	1.99
Junc 3	25	53.6	107.2	36.77	11.77	Pipe 3	244.89	150	110	656	0.43	2.16
Junc 4	25	31.8	63.6	36.24	11.24	Pipe 4	328.24	150	110	592.4	0.39	1.79
Junc 5	25	53.6	107.2	35.65	10.65	Pipe 5	266.36	150	110	318	0.21	0.57
Junc 6	25	31.8	63.6	35.5	10.5	Pipe 6	382.38	150	110	254.4	0.17	0.37
Junc 7	25	31.8	63.6	35.36	10.36	Pipe 7	312.99	100	110	190.8	0.28	1.58
Junc 8	25	31.8	63.6	34.86	9.86	Pipe 8	343.47	100	110	127.2	0.19	0.75
Junc 9	25	31.8	63.6	34.6	9.6	Pipe 9	366.24	100	110	63.6	0.09	0.21
Junc 10	25	31.8	63.6	34.53	9.53	Pipe 10	369.57	150	110	572.4	0.37	1.68
Junc 11	25	31.8	63.6	36.15	11.15	Pipe 11	360.14	150	110	508.8	0.33	1.35
Junc 12	25	53.6	107.2	35.66	10.66	Pipe 12	266.54	150	110	318	0.21	0.57
Junc 13	25	31.8	63.6	35.51	10.51	Pipe 13	258.42	150	110	254.4	0.17	0.37
Junc 14	25	31.8	63.6	35.41	10.41	Pipe 14	234.91	150	110	190.8	0.12	0.22
Junc 15	25	31.8	63.6	35.36	10.36	Pipe 15	717.04	100	110	127.2	0.19	0.75
Junc 16	25	31.8	63.6	34.83	9.83	Pipe 16	975.66	100	110	63.6	0.09	0.21
Junc 17	25	31.8	63.6	34.62	9.62	Pipe 17	340.69	50	110	83.6	0.49	10.05
Junc 18	25	31.8	63.6	31.45	6.45	Pipe 18	451.43	50	110	20	0.12	0.71
Junc 19	25	10	20	31.28	6.28	Pipe 19	278.23	50	110	83.6	0.49	10.05
Junc 20	25	31.8	63.6	32.85	7.85	Pipe 20	185.16	50	110	20	0.12	0.71
Junc 21	25	10	20	32.72	7.72	Pipe 21	419.41	50	110	83.6	0.49	10.05
Junc 22	25	31.8	63.6	32.23	7.23	Pipe 22	233.7	50	110	20	0.12	0.71
Junc 23	25	10	20	31.91	6.91							

(2) Location of junctions



(3) Location of links



14.9 FBG-13

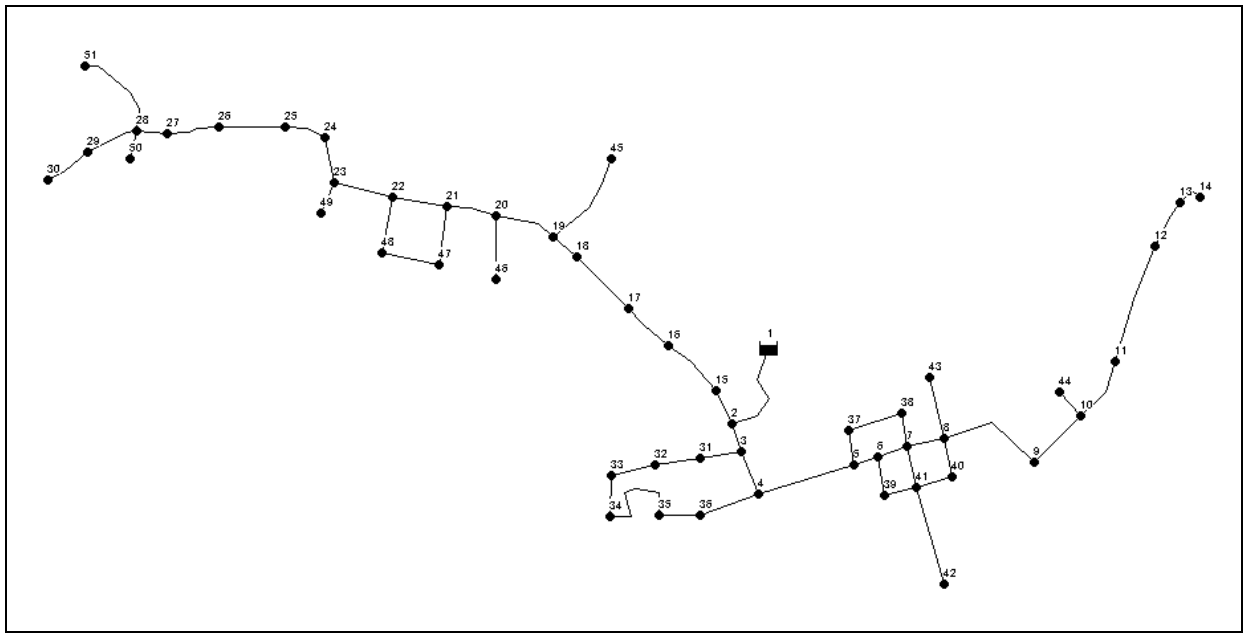
(1) Result of distribution network analysis - 1

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	164		−7908.6	164.0	0.0	Pipe 1	1181.4	400	110	7908.6	0.7	1.8
Junc 2	120	50.8	101.6	161.8	41.8	Pipe 2	331.2	350	110	4597.2	0.6	1.3
Junc 3	120	50.8	101.6	161.4	41.4	Pipe 3	542.0	350	110	4142.5	0.5	1.1
Junc 4	120	50.8	101.6	160.8	40.8	Pipe 4	1149.4	350	110	3784.4	0.5	0.9
Junc 5	120	80.6	161.2	159.8	39.8	Pipe 5	289.9	350	110	3460.4	0.4	0.8
Junc 6	120	80.6	161.2	159.6	39.6	Pipe 6	358.0	350	110	3200.6	0.4	0.7
Junc 7	120	80.6	161.2	159.4	39.4	Pipe 7	442.7	350	110	2431.4	0.3	0.4
Junc 8	120	80.6	161.2	159.2	39.2	Pipe 8	1263.7	350	110	2011.2	0.2	0.3
Junc 9	120	80.6	161.2	158.8	38.8	Pipe 9	756.9	300	110	1850.0	0.3	0.5
Junc 10	125	80.6	161.2	158.5	33.5	Pipe 10	762.8	300	110	1527.6	0.3	0.4
Junc 11	130	80.6	161.2	158.2	28.2	Pipe 11	1426.9	300	110	1366.4	0.2	0.3
Junc 12	130	80.6	161.2	157.8	27.8	Pipe 12	576.4	300	110	1205.2	0.2	0.2
Junc 13	135	80.6	161.2	157.6	22.6	Pipe 13	321.4	300	110	1044.0	0.2	0.2
Junc 14	135	522.0	1044.0	157.6	22.6	Pipe 14	437.4	300	110	3209.8	0.5	1.4
Junc 15	120	50.8	101.6	161.2	41.2	Pipe 15	761.9	300	110	3108.2	0.5	1.3
Junc 16	120	50.8	101.6	160.2	40.2	Pipe 16	634.3	300	110	3006.6	0.5	1.2
Junc 17	120	50.8	101.6	159.4	39.4	Pipe 17	849.4	300	110	2905.0	0.5	1.2
Junc 18	120	50.8	101.6	158.5	38.5	Pipe 18	355.0	300	110	2803.4	0.5	1.1
Junc 19	120	50.8	101.6	158.1	38.1	Pipe 19	733.7	300	110	2600.2	0.4	1.0
Junc 20	120	50.8	101.6	157.4	37.4	Pipe 20	583.9	250	110	2397.0	0.6	2.0
Junc 21	120	79.9	159.8	156.2	36.2	Pipe 21	639.3	250	110	2077.6	0.5	1.5
Junc 22	120	79.9	159.8	155.2	35.2	Pipe 22	698.5	250	110	1757.8	0.4	1.1
Junc 23	120	79.9	159.8	154.5	34.5	Pipe 23	542.2	250	110	1438.2	0.3	0.8
Junc 24	125	79.9	159.8	154.0	29.0	Pipe 24	492.2	250	110	1278.4	0.3	0.6
Junc 25	120	79.9	159.8	153.7	33.7	Pipe 25	770.0	250	110	1118.6	0.3	0.5
Junc 26	120	79.9	159.8	153.4	33.4	Pipe 26	608.9	250	110	958.8	0.2	0.4
Junc 27	120	79.9	159.8	153.1	33.1	Pipe 27	347.9	250	110	799.0	0.2	0.3
Junc 28	120	129.8	259.6	153.1	33.1	Pipe 28	626.1	250	110	319.6	0.1	0.1
Junc 29	120	79.9	159.8	153.0	33.0	Pipe 29	566.6	250	110	159.8	0.0	0.0
Junc 30	120	79.9	159.8	153.0	33.0	Pipe 30	483.6	125	110	353.1	0.3	1.7
Junc 31	120	50.8	101.6	160.6	40.6	Pipe 31	538.0	125	110	251.5	0.2	0.9
Junc 32	120	50.8	101.6	160.1	40.1	Pipe 32	523.0	125	110	149.9	0.1	0.3
Junc 33	120	50.8	101.6	160.0	40.0	Pipe 33	477.5	125	110	48.3	0.1	0.0
Junc 34	120	50.8	101.6	159.9	39.9	Pipe 34	1218.4	125	110	−53.3	0.1	0.1
Junc 35	120	50.8	101.6	160.0	40.0	Pipe 35	477.5	125	110	−154.9	0.2	0.4
Junc 36	120	50.8	101.6	160.2	40.2	Pipe 36	733.0	125	110	−256.5	0.2	0.9
Junc 37	120	80.6	161.2	146.4	26.4	Pipe 37	388.8	50	110	162.8	1.0	34.5
Junc 38	120	80.6	161.2	146.4	26.4	Pipe 38	640.4	50	110	1.6	0.0	0.0
Junc 39	120	80.6	161.2	153.4	33.4	Pipe 39	389.9	50	110	−159.6	0.9	33.3
Junc 40	120	80.6	161.2	153.1	33.1	Pipe 40	454.6	50	110	98.6	0.6	13.7
Junc 41	120	80.6	161.2	155.6	35.6	Pipe 41	381.0	50	110	−62.6	0.4	5.9
Junc 42	120	80.6	161.2	154.3	34.3	Pipe 42	426.3	50	110	63.5	0.4	6.0
Junc 43	120	80.6	161.2	134.5	14.5	Pipe 43	456.1	50	110	−97.8	0.6	13.4
Junc 44	125	80.6	161.2	145.9	20.9	Pipe 44	483.7	100	110	448.4	0.7	7.7
Junc 45	120	50.8	101.6	141.4	21.4	Pipe 45	1167.8	100	110	161.2	0.2	1.2
Junc 46	120	50.8	101.6	146.7	26.7	Pipe 46	726.7	50	110	161.2	1.0	33.9
Junc 47	120	79.9	159.8	133.4	13.4	Pipe 47	370.9	50	110	161.2	1.0	33.9
Junc 48	120	79.9	159.8	133.4	13.4	Pipe 48	1158.8	50	110	101.6	0.6	14.4
Junc 49	120	79.9	159.8	141.4	21.4	Pipe 49	739.3	50	110	101.6	0.6	14.4
Junc 50	120	79.9	159.8	141.9	21.9	Pipe 50	685.0	50	110	159.6	0.9	33.3
Junc 51	120	30.0	60.0	147.0	27.0	Pipe 51	676.6	50	110	−0.2	0.0	0.0
						Pipe 52	652.4	50	110	−160.0	0.9	33.5
						Pipe 53	392.7	50	110	159.8	0.9	33.4
						Pipe 54	1111.7	50	110	60.0	0.4	5.4
						Pipe 55	334.3	50	110	159.8	0.9	33.4

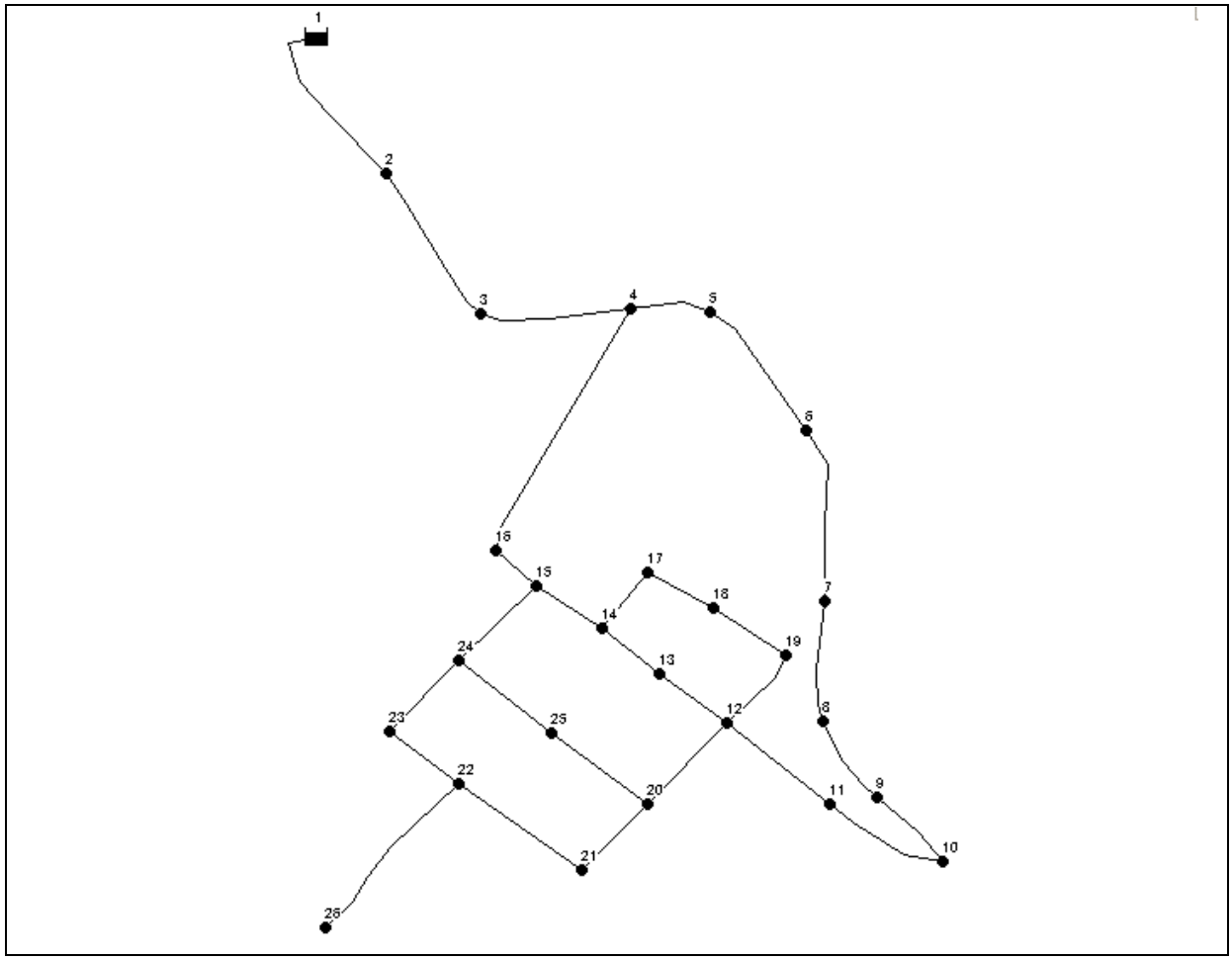
(2) Result of distribution network analysis - 2

Network Table – Nodes						Network Table – Links						
Node ID	Elevation m	Base Demand m3/d	Demand m3/d	Head m	Pressure m	Link ID	Length m	Diameter mm	Roughness	Flow m3/d	Velocity m/s	Unit Headloss m/km
Resvr 1	185		−2095.8	185.0	0.0	Pipe 1	969.0	250	110	2095.8	0.5	1.5
Junc 2	145	0	0	183.5	38.5	Pipe 2	853.1	250	110	2095.8	0.5	1.5
Junc 3	145	0	0	182.2	37.2	Pipe 3	768.1	250	110	2095.8	0.5	1.5
Junc 4	150	0	0	181.0	31.0	Pipe 4	410.4	200	110	915.2	0.3	1.0
Junc 5	155	0	0	180.6	25.6	Pipe 5	770.0	200	110	915.2	0.3	1.0
Junc 6	160	49.9	99.8	179.8	19.8	Pipe 6	892.3	200	110	815.4	0.3	0.8
Junc 7	140	49.9	99.8	179.1	39.1	Pipe 7	605.8	200	110	715.6	0.3	0.6
Junc 8	140	49.9	99.8	178.7	38.7	Pipe 8	483.1	200	110	615.8	0.2	0.5
Junc 9	138	49.9	99.8	178.5	40.5	Pipe 9	454.8	200	110	516.0	0.2	0.3
Junc 10	135	49.9	99.8	178.4	43.4	Pipe 10	641.5	200	110	416.2	0.2	0.2
Junc 11	135	49.9	99.8	178.2	43.2	Pipe 11	663.0	200	110	316.4	0.1	0.1
Junc 12	135	49.9	99.8	178.1	43.1	Pipe 12	425.2	200	110	−257.2	0.1	0.1
Junc 13	135	49.9	99.8	178.2	43.2	Pipe 13	361.9	200	110	−357.0	0.1	0.2
Junc 14	135	49.9	99.8	178.2	43.2	Pipe 14	391.9	200	110	−621.0	0.2	0.5
Junc 15	135	49.9	99.8	178.4	43.4	Pipe 15	271.4	200	110	−1080.8	0.4	1.3
Junc 16	135	49.9	99.8	178.8	43.8	Pipe 16	1405.3	200	110	−1180.6	0.4	1.6
Junc 17	138	49.9	99.8	177.8	39.8	Pipe 17	366.0	100	110	164.2	0.2	1.2
Junc 18	138	49.9	99.8	177.7	39.7	Pipe 18	375.1	100	110	64.4	0.1	0.2
Junc 19	138	49.9	99.8	177.7	39.7	Pipe 19	434.0	100	110	−35.4	0.1	0.1
Junc 20	130	49.9	99.8	175.5	45.5	Pipe 20	460.3	100	110	−135.2	0.2	0.8
Junc 21	130	49.9	99.8	174.8	44.8	Pipe 21	569.6	100	110	338.6	0.5	4.6
Junc 22	130	49.9	99.8	174.5	44.5	Pipe 22	471.5	100	110	190.1	0.3	1.6
Junc 23	125	49.9	99.8	174.7	49.7	Pipe 23	752.9	100	110	90.3	0.1	0.4
Junc 24	130	49.9	99.8	175.7	45.7	Pipe 24	438.4	100	110	−109.3	0.2	0.6
Junc 25	130	49.9	99.8	173.3	43.3	Pipe 25	499.5	100	110	−209.1	0.3	1.9
Junc 26	125	49.9	99.8	160.7	35.7	Pipe 26	537.0	100	110	−360.0	0.5	5.1
						Pipe 27	591.8	50	110	51.0	0.3	4.0
						Pipe 28	604.8	50	110	−48.8	0.3	3.7
						Pipe 29	990.5	50	110	99.8	0.6	14.0

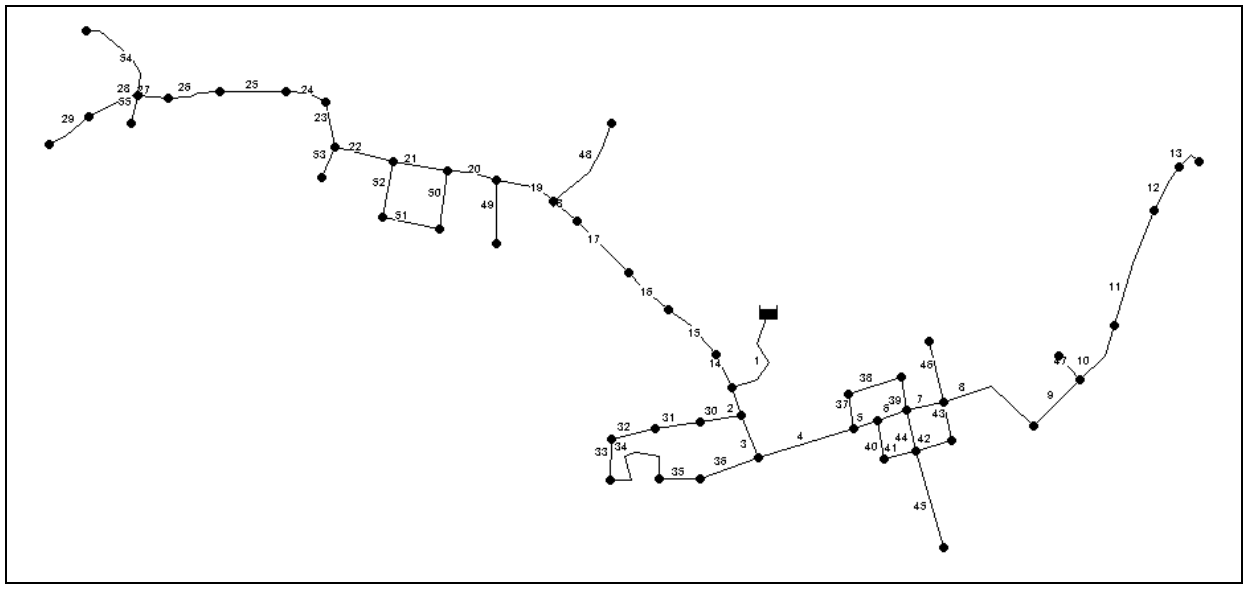
(3) Location of junctions -1



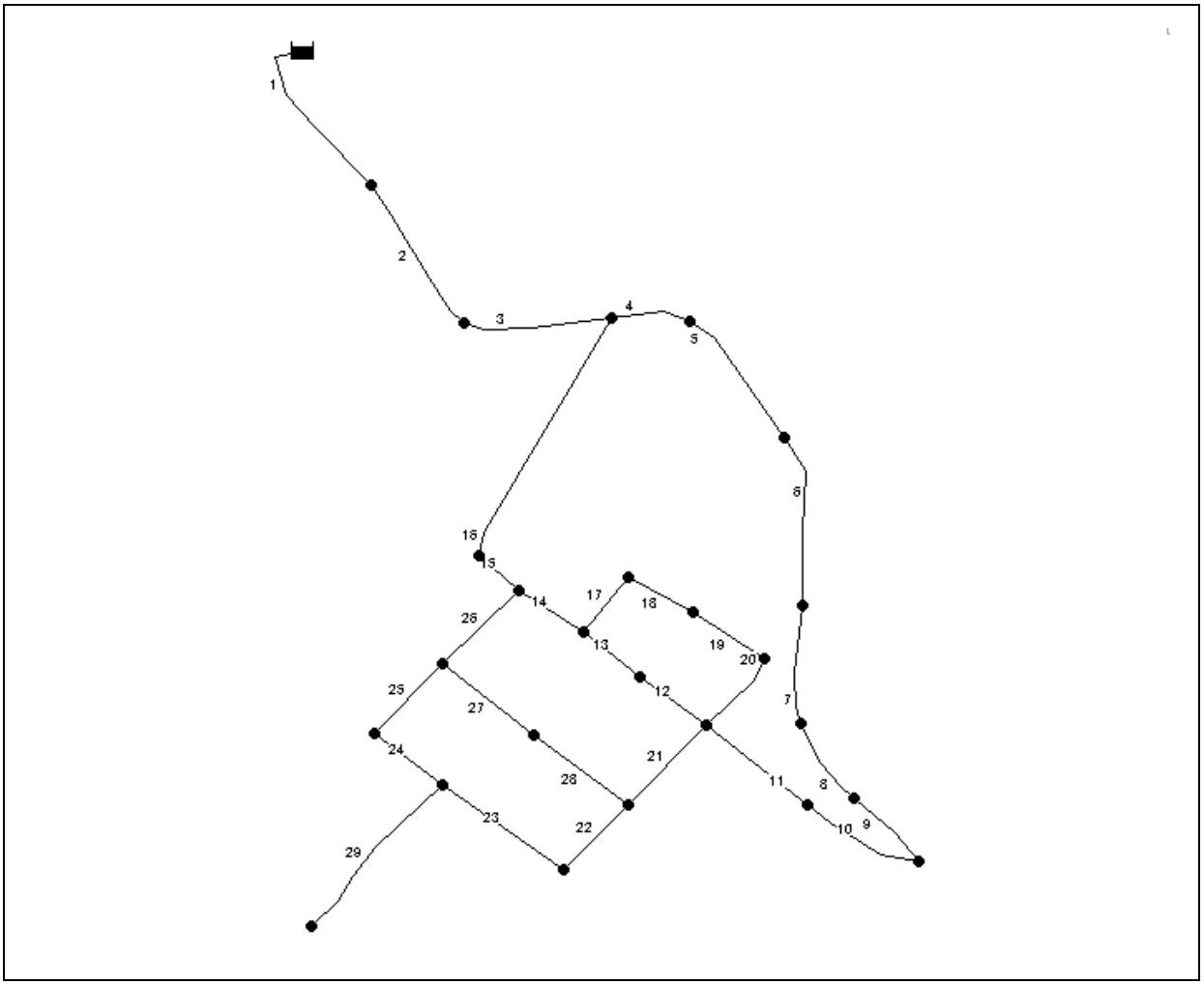
(4) Location of junctions -2



(5) Location of links -1



(6) Location of links – 2



CHAPTER 15

COST ESTIMATION

CHAPTER 15 COST ESTIMATION

15.1 Construction Cost of Water Supply Facility

The construction cost of water supply facility and its cost break down are shown from next page.

(1) Summary

	Component	Cost (JPY)									Total
		FPS2	FPS3	FPG4	FPS5	FKS6	FKS8	FNG10	FBS11	FBG13	
1-1	Intake facility	**3,229,000**	**12,209,800**	**22,204,900**	**4,840,500**	**5,043,500**	**8,721,700**	**21,226,150**	**5,816,250**	**35,882,800**	**119,174,600**
	1) Civil works	0	4,068,000	15,000,000	2,034,000	2,034,000	4,034,000	15,000,000	2,000,000	15,000,000	59,170,000
	2) Mechanical and Electrical works	1,479,000	5,341,800	5,454,900	1,406,500	1,609,500	2,937,700	4,476,150	2,066,250	18,782,800	43,554,600
	3) Building works	1,750,000	2,800,000	1,750,000	1,400,000	1,400,000	1,750,000	1,750,000	1,750,000	2,100,000	16,450,000
1-2	Raw water transmission pipelines & Clean water transmission pipelines	**19,108,800**	**4,416,100**	**56,374,500**	**6,635,000**	**1,561,000**	**39,744,900**	**313,033,140**	**29,145,800**	**112,754,900**	**582,774,140**
1-3	Water treatment plant	**69,512,000**		**95,537,500**		**40,313,100**	**46,924,000**	**217,495,900**	**70,394,200**	**342,822,000**	**882,998,700**
	1) Civil works	38,450,000		52,450,000		25,000,000	4,100,000	128,750,000	36,950,000	209,550,000	495,250,000
	2) Mechanical and Electrical works	19,862,000		30,837,500		6,913,100	31,624,000	69,595,900	22,244,200	107,872,000	288,948,700
	3) Building works	11,200,000		12,250,000		8,400,000	11,200,000	19,150,000	11,200,000	25,400,000	98,800,000
1-4	Distribution facility	**50,958,300**	**65,691,000**	**143,922,000**	**52,786,000**	**33,818,000**	**46,707,750**	**210,803,000**	**33,949,550**	**389,377,800**	**1,028,013,400**
	1) Civil works	10,000,000	20,000,000	16,650,000	13,350,000	10,000,000	10,000,000	43,350,000	11,650,000	75,000,000	210,000,000
	2) Mechanical and Electrical cost	1,905,300	0	8,787,000	3,441,000	0	3,675,750	12,847,000	4,145,550	19,957,800	54,759,400
	3) Building works	0	2,800,000	0	4,550,000	0	0	0	0	0	7,350,000
	4) Primary distribution mains	39,053,000	42,891,000	118,485,000	31,445,000	23,818,000	33,032,000	154,606,000	18,154,000	294,420,000	755,904,000
1-5	Distribution pump station			**3,732,700**				**11,285,250**		**10,510,950**	**25,528,900**
	1) Civil works			0				0		0	**0**
	2) Mechanical and Electrical cost			2,357,700				9,635,250		8,860,950	20,853,900
	3) Building cost			1,375,000				1,650,000		1,650,000	4,675,000

(1) Summary

Component	Cost (JPY)									Total
	FPS2	FPS3	FPG4	FPS5	FKS6	FKS8	FNG10	FBS11	FBG13	
1-6 House connection	**5,586,000**	**10,536,000**	**9,419,000**	**6,883,000**	**4,051,000**	**4,458,000**	**16,989,000**	**5,433,000**	**34,744,000**	**98,099,000**
1) House connection pipes	1,371,000	2,586,000	2,312,000	1,690,000	994,000	1,094,000	4,170,000	1,334,000	8,529,000	24,080,000
2) Water meter	4,215,000	7,950,000	7,107,000	5,193,000	3,057,000	3,364,000	12,819,000	4,099,000	26,215,000	74,019,000
1-7 Administration building									14,000,000	**14,000,000**
Total (1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 1-9)	**148,394,100**	**92,852,900**	**331,190,600**	**71,144,500**	**84,786,600**	**146,556,350**	**790,832,440**	**144,738,800**	**940,092,450**	**2,750,588,740**

(2) Cost Break Down

USD1 = 106.17 yen

1) FPS2

1)-1 Intake facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			0		
2)	Mechanical and Electrical works			1,479,000		
2.1)	Centrifugal pumps 1.5kW x (2+1 units)	3 nos	493,000	1,479,000		
3)	Building works	25 m2	70,000	1,750,000		

1)-2 Raw water transmission pipelines and Clear water transmission

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Raw water transmission pipelines and Clear water transmission			19,108,800		
1.1)	Pipe Dia. 125mm PVC	7,200 m	2,654	19,108,800		

1)-2 Water treatment plant

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			38,450,000		
1.1)	Coagulation and Sedimentation basin	Capacity 490 m3	50,000	24,500,000		
1.2)	Filtration basin	Capacity 221 m3	50,000	11,050,000		
1.3)	Treated water reservoir	Capacity 58 m3	50,000	2,900,000		
2)	Mechanical and Electrical works			19,862,000		
2.1)	Mechanical and Electrical works	1 set	19,862,000	19,862,000		
3)	Building works			11,200,000		
3.1)	Administration office	30 m2	140,000	4,200,000		
3.2)	Pump station	35 m2	70,000	2,450,000		
3.3)	Chemical building	40 m2	70,000	2,800,000		
3.4)	Chlorinator building	25 m2	70,000	1,750,000		
3.5)	Operation building of filtration basin	0 m2	55,000	0		

1)-3 Distribution facility

	Component	Quantity		Cost (JPY)			
				Unit	Amount	Foreign Component	Local Component
1)	Civil works				10,000,000		
		Capacity					
1.1)	Distribution reservoir	200	m3	50,000	10,000,000		
2)	Mechanical and Electrical works				1,905,300		
2.1)	Centrifugal pumps 3.7kW x (2+1 units)	3	nos	635,100	1,905,300		
3)	Building works		m2				
4)	Primary distribution mains				39,053,000		
4.1)	Pipe Dia. 50mm PVC	5,781	m	1,168	6,752,000		
4.2)	Pipe Dia. 65mm PVC	387	m	1,380	534,000		
4.3)	Pipe Dia. 80mm PVC	6,195	m	1,699	10,525,000		
4.4)	Pipe Dia. 100mm PVC	3,121	m	2,230	6,960,000		
4.5)	Pipe Dia. 125mm PVC	3,338	m	2,654	8,859,000		
4.6)	Pipe Dia. 150mm PVC	0	m	3,397	0		
4.7)	Pipe Dia. 200mm PVC	1,135	m	4,778	5,423,000		
4.8)	Fittings and valves		%		0		
4.9)	Extra works such as sheeting		%		0		

1)-4 Distribution pump station

	Component	Quantity		Cost (JPY)			
				Unit	Amount	Foreign Component	Local Component
1)	Civil works						
2)	Mechanical and Electrical works		set				
3)	Building works		set				

1)-5 House connection

	Component	Quantity		Cost (JPY)			
				Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	17,140	m	80	1,371,000		
2)	Water meter	1,714	nos	2,459	4,215,000		

1)-6 Administration building

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Administration building	1 set				

USD1 = 106.17 yen

2) FPS3

2)-1 Intake facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			4,068,000		
	Deep wells (plus 1 stand by)	4 nos	1,017,000	4,068,000		
2)	Mechanical and Electrical works			5,341,800		
2.1)	Submersible pumps 5.5kW x (3 units) (plus 1 stand by)	4 nos	1,335,450	5,341,800		
3)	Building works 10 m2 × 4 locations=40 m2	40 m2	70,000	2,800,000		

2)-2 Raw water transmission pipelines and Clear water transmission

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Raw water transmission pipelines and Clear water transmission			4,416,100		
1.1)	Pipe Dia. 150mm PVC	1,300 m	3,397	4,416,100		

2)-3 Water treatment plant

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			0		
1.1)	Coagulation and Sedimentation basin	Capacity m3	50,000	0		
1.2)	Filtration basin	Capacity m3	50,000	0		
1.3)	Treated water reservoir	Capacity m3	50,000	0		
2)	Mechanical and Electrical works			0		
2.1)	Mechanical and Electrical works	set		0		
3)	Building works					

2)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			20,000,000		
		Capacity				
1.1)	Distribution reservoir	400 m3	50,000	20,000,000		
2)	Mechanical and Electrical works					
3)	Building works			2,800,000		
3.1)	Administration office	20 m2	140,000	2,800,000		
3.2)	Pump station	m2	70,000	0		
3.3)	Chemical building	m2	70,000	0		
3.4)	Chlorinator building	m2	70,000	0		
3.5)	Operation building of filtration basin	m2	55,000	0		
4)	Primary distribution mains			42,891,000		
4.1)	Pipe Dia. 50mm PVC	2,854 m	1,168	3,333,000		
4.2)	Pipe Dia. 65mm PVC	0 m	1,380	0		
4.3)	Pipe Dia. 80mm PVC	1,229 m	1,699	2,088,000		
4.4)	Pipe Dia. 100mm PVC	1,030 m	2,230	2,297,000		
4.5)	Pipe Dia. 125mm PVC	0 m	2,654	0		
4.6)	Pipe Dia. 150mm PVC	3,976 m	3,397	13,506,000		
4.7)	Pipe Dia. 200mm PVC	1,361 m	4,778	6,503,000		
4.8)	Pipe Dia. 250mm PVC	2,267 m	6,689	15,164,000		
4.9)	Fittings and valves	%		0		
4.10)	Extra works such as sheeting	%		0		

2)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works	set				
3)	Building works	set				

2)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	32,330 m	80	2,586,000		
2)	Water meter	3,233 nos	2,459	7,950,000		

2)-7 Administration building

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Administration building	1 set				

USD1 = 106.17 yen

3) FPG4

3)-1 Intake facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			15,000,000		
1.1)	Intake facility	1 no	15,000,000	15,000,000		
2)	Mechanical and Electrical works			5,454,900		
2.1)	Submersible pumps 15kW x (2+1 units)	3 nos	1,818,300	5,454,900		
3)	Building works	25 m2	70,000	1,750,000		

3)-2 Raw water transmission pipelines and Clear water transmission

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Raw water transmission pipelines and Clear water transmission			56,374,500		
1.1)	Pipe Dia. 150mm DCI	5,900 m	9,555	56,374,500		

3)-3 Water treatment plant

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			52,450,000		
1.1)	Coagulation and Sedimentation basin	Capacity 677 m3	50,000	33,850,000		
1.2)	Filtration basin	Capacity 280 m3	50,000	14,000,000		
1.3)	Treated water reservoir	Capacity 92 m3	50,000	4,600,000		
2)	Mechanical and Electrical works			30,837,500		
2.1)	Mechanical and Electrical works	1 set	30,837,500	30,837,500		
3)	Building works			12,250,000		
3.1)	Administration office	30 m2	140,000	4,200,000		
3.2)	Pump station	40 m2	70,000	2,800,000		
3.3)	Chemical building	50 m2	70,000	3,500,000		
3.4)	Chlorinator building	25 m2	70,000	1,750,000		
3.5)	Operation building of filtration basin	0 m2	55,000	0		

3)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			16,650,000		
		Capacity				
1.1)	Distribution reservoir	333 m3	50,000	16,650,000		
2)	Mechanical and Electrical works			8,787,000		
2.1)	Centrifugal pumps 5.5kW x (2+1 units)	3 nos	1,464,500	4,393,500		
2.2)	Centrifugal pumps 3.7kW x (2+1 units)	3 nos	1,464,500	4,393,500		
3)	Building works			0		
4)	Primary distribution mains			118,485,000		
4.1)	Pipe Dia. 50mm PVC	14,295 m	1,168	16,697,000		
4.2)	Pipe Dia. 65mm PVC	2,411 m	1,380	3,327,000		
4.3)	Pipe Dia. 80mm PVC	0 m	1,699	0		
4.4)	Pipe Dia. 100mm PVC	1,618 m	2,230	3,608,000		
4.5)	Pipe Dia. 125mm PVC	0 m	2,654	0		
4.6)	Pipe Dia. 150mm PVC	20,295 m	3,397	68,942,000		
4.7)	Pipe Dia. 200mm PVC	5,423 m	4,778	25,911,000		
4.8)	Pipe Dia. 250mm PVC	0 m	6,689	0		
4.9)	Fittings and valves	%		0		
4.10)	Extra works such as sheeting	%		0		

3)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works			2,357,700		
2.1)	Centrifugal pumps 1.1kW x (2+1 units)	3 nos	785,900	2,357,700		
3)	Building works	25 m2	55,000	1,375,000		

3)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes	28,900 m	80	2,312,000		
2)	Water meter	2,890 nos	2,459	7,107,000		

3)-7 Administration building

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Administration building	1 set				

USD1 = 106.17 yen

4) FPS5

4)-1 Intake facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			2,034,000		
	Deep wells	2 nos	1,017,000	2,034,000		
2)	Mechanical and Electrical works			1,406,500		
2.1)	Submersible pumps 2.2kW x (2 units)	2 nos	703,250	1,406,500		
3)	Building works 10 m2 × 2 locations =20 m2	20 m2	70,000	1,400,000		

4)-2 Raw water transmission pipelines and Clear water transmission

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Raw water transmission pipelines and Clear water transmission			6,635,000		
1.1)	Pipe Dia. 125mm PVC	2,500 m	2,654	6,635,000		

4)-3 Water treatment plant

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			0		
1.1)	Coagulation and Sedimentation basin	Capacity m3	50,000	0		
1.2)	Filtration basin	Capacity m3	50,000	0		
1.3)	Treated water reservoir	Capacity m3	50,000	0		
2)	Mechanical and Electrical works			0		
2.1)	Mechanical and Electrical works	set		0		
3)	Building works					

4)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			13,350,000		
1.1)	Distribution reservoir	Capacity 267 m3	50,000	13,350,000		
2)	Mechanical and Electrical works			3,441,000		
2.1)	Centrifugal pumps 2.2kW x (2+1 units)	3 nos	1,146,950	3,441,000		
3)	Building works			4,550,000		
3.1)	Administration office	20 m2	140,000	2,800,000		
3.2)	Pump station	25 m2	70,000	1,750,000		
3.3)	Chemical building	m2	70,000	0		
3.4)	Chlorinator building	m2	70,000	0		
3.5)	Operation building of filtration basin	m2	55,000	0		
4)	Primary distribution mains			31,445,000		
4.1)	Pipe Dia. 50mm PVC	6,874 m	1,168	8,029,000		
4.2)	Pipe Dia. 65mm PVC	0 m	1,380	0		
4.3)	Pipe Dia. 80mm PVC	1,320 m	1,699	2,243,000		
4.4)	Pipe Dia. 100mm PVC	3,113 m	2,230	6,942,000		
4.5)	Pipe Dia. 125mm PVC	0 m	2,654	0		
4.6)	Pipe Dia. 150mm PVC	4,009 m	3,397	13,619,000		
4.7)	Pipe Dia. 200mm PVC	128 m	4,778	612,000		
4.8)	Pipe Dia. 250mm PVC	0 m	6,689	0		
4.9)	Fittings and valves	%		0		
4.10)	Extra works such as sheeting	%		0		

4)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works	set				
3)	Building works	set				

4)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	21,120 m	80	1,690,000		
2)	Water meter	2,112 nos	2,459	5,193,000		

4)-7 Administration building

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Administration building	1 set				

USD1 = 106.17 yen

5) FKS6

5)-1 Intake facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			2,034,000		
	Deep wells	2 nos	1,017,000	2,034,000		
2)	Mechanical and Electrical works			1,609,500		
2.1)	Submersible pumps 3.7kW x (2units)	2 nos	804,750	1,609,500		
3)	Building works 10 m2 × 2 locations=20 m2	20 m2	70,000	1,400,000		

5)-2 Raw water transmission pipelines and Clear water transmission

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Raw water transmission pipelines and Clear water transmission			1,561,000		
1.1)	Pipe Dia. 100mm PVC	700 m	2,230	1,561,000		

5)-3 Water treatment plant

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			25,000,000		
1.1)	Coagulation and Sedimentation basin	Capacity m3	50,000	0		
1.2)	Filtration basin	Capacity 450 m3	50,000	22,500,000		
1.3)	Treated water reservoir	Capacity 50 m3	50,000	2,500,000		
2)	Mechanical and Electrical works			6,913,100		
2.1)	Mechanical and Electrical works	1 set	6,913,100	6,913,100		
3)	Building works			8,400,000		
3.1)	Administration office	30 m2	140,000	4,200,000		
3.2)	Pump station	35 m2	70,000	2,450,000		
3.3)	Chemical building	m2	70,000	0		
3.4)	Chlorinator building	25 m2	70,000	1,750,000		
3.5)	Operation building of filtration basin	m2	55,000	0		

5)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			10,000,000		
1.1)	Distribution reservoir	Concrete 200 m3	50,000	10,000,000		
2)	Mechanical and Electrical works					
3)	Building works					
4)	Primary distribution mains			23,818,000		
4.1)	Pipe Dia. 50mm PVC	949 m	1,168	1,108,000		
4.2)	Pipe Dia. 65mm PVC	344 m	1,380	475,000		
4.3)	Pipe Dia. 80mm PVC	0 m	1,699	0		
4.4)	Pipe Dia. 100mm PVC	3,989 m	2,230	8,895,000		
4.5)	Pipe Dia. 125mm PVC	0 m	2,654	0		
4.6)	Pipe Dia. 150mm PVC	0 m	3,397	0		
4.7)	Pipe Dia. 200mm PVC	2,792 m	4,778	13,340,000		
4.8)	Pipe Dia. 250mm PVC	0 m	6,689	0		
4.9)	Fittings and valves	%		0		
4.10)	Extra works such as sheeting	%		0		

5)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works	set				
3)	Building works	set				

5)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	12,430 m	80	994,000		
2)	Water meter	1,243 nos	2,459	3,057,000		

5)-7 Administration building

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Administration building	1 set				

USD1 = 106.17 yen

6) FKS8

6)-1 Intake facility

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Civil works			4,034,000		
1.1) Intake facility	1 no	2,000,000	2,000,000		
1.2) Deep wells	2 nos	1,017,000	2,034,000		
2) Mechanical and Electrical works			2,937,700		
2.1) Submersible pumps for river 0.5kW x (2+1 units)	3 nos	510,400	1,531,200		
2.2) Submersible pumps for wells 2.2kW x (2 units)	2 nos	703,250	1,406,500		
3) Building works			1,750,000		
3.1) River intake	25 m2	70,000	1,750,000		
3.2) Wells (2 deep wells)	20 m2	70,000	1,400,000		

6)-2 Raw water transmission pipelines and Clear water transmission

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Raw water transmission pipelines and Clear water transmission			39,744,900		
1.1) Pipe Dia. 150mm PVC	11,700 m	3,397	39,744,900		

6)-3 Water treatment plant

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Civil works			4,100,000		
1.1) Coagulation and Sedimentation basin	Capacity 14 m3	50,000	700,000		
1.2) Filtration basin	Capacity 14 m3	50,000	700,000		
1.3) Treated water reservoir	Capacity 54 m3	50,000	2,700,000		
2) Mechanical and Electrical works			31,624,000		
2.1) Mechanical and Electrical works	1 set	31,624,000	31,624,000		
3) Building works			11,200,000		
3.1) Administration office	30 m2	140,000	4,200,000		
3.2) Pump station	35 m2	70,000	2,450,000		
3.3) Chemical building	40 m2	70,000	2,800,000		
3.4) Chlorinator building	25 m2	70,000	1,750,000		
3.5) Operation building of filtration basin	0 m2	55,000	0		

6)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			10,000,000		
		Capacity				
1.1)	Distribution reservoir	200 m3	50,000	10,000,000		
2)	Mechanical and Electrical works			3,675,750		
2.1)	Centrifugal pumps 3.7kW x (2+1 units)	3 nos	1,225,250	3,675,750		
3)	Building works			0		
4)	Primary distribution mains			33,032,000		
4.1)	Pipe Dia. 50mm PVC	6,302 m	1,168	7,361,000		
4.2)	Pipe Dia. 65mm PVC	0 m	1,380	0		
4.3)	Pipe Dia. 80mm PVC	0 m	1,699	0		
4.4)	Pipe Dia. 100mm PVC	1,980 m	2,230	4,415,000		
4.5)	Pipe Dia. 125mm PVC	0 m	2,654	0		
4.6)	Pipe Dia. 150mm PVC	2,582 m	3,397	8,771,000		
4.7)	Pipe Dia. 200mm PVC	2,613 m	4,778	12,485,000		
4.8)	Pipe Dia. 250mm PVC	0 m	6,689	0		
4.9)	Fittings and valves	%		0		
4.10)	Extra works such as sheeting	%		0		

6)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works					
3)	Building works					

6)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	13,680 m	80	1,094,000		
2)	Water meter	1,368 nos	2,459	3,364,000		

6)-7 Administration building

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Administration building	1 set				

USD1 = 106.17 yen

7) FNG10

7)-1 Intake facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			15,000,000		
1.1)	Intake facility	1 no	15,000,000	15,000,000		
2)	Mechanical and Electrical works			4,476,150		
2.1)	Submersible pumps 3.7kW x (2+1 units)	3 nos	1,492,050	4,476,150		
3)	Building works	25 m2	70,000	1,750,000		

7)-2 Raw water transmission pipelines and Clear water transmission

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Raw water transmission pipelines and Clear water transmission			313,033,140		
1.1)	Pipe Dia. 300mm DCI	11,340 m	19,111	216,718,740		
1.2)	Pipe Dia. 200mm DCI	7,560 m	12,740	96,314,400		

7)-3 Water treatment plant

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			128,750,000		
1.1)	Coagulation and Sedimentation basin	Capacity 1,508 m3	50,000	75,400,000		
1.2)	Filtration basin	Capacity 825 m3	50,000	41,250,000		
1.3)	Treated water reservoir	Capacity 242 m3	50,000	12,100,000		
2)	Mechanical and Electrical works			69,595,900		
2.1)	Mechanical and Electrical works	1 set	69,595,900	69,595,900		
3)	Building works			19,150,000		
3.1)	Administration office	30 m2	140,000	4,200,000		
3.2)	Pump station	50 m2	70,000	3,500,000		
3.3)	Chemical building	60 m2	70,000	4,200,000		
3.4)	Chlorinator building	25 m2	70,000	1,750,000		
3.5)	Operation building of filtration basin	100 m2	55,000	5,500,000		

7)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			43,350,000		
		Capacity				
1.1)	Distribution reservoir	867 m3	50,000	43,350,000		
2)	Mechanical and Electrical works			12,847,000		
2.1)	Centrifugal pumps 22kW x (3+1 units)	4 nos	3,211,750	12,847,000		
3)	Building works			0		
4)	Primary distribution mains			154,606,000		
4.1)	Pipe Dia. 50mm PVC	795 m	1,168	929,000		
4.2)	Pipe Dia. 65mm PVC	0 m	1,380	0		
4.3)	Pipe Dia. 80mm PVC	0 m	1,699	0		
4.4)	Pipe Dia. 100mm PVC	0 m	2,230	0		
4.5)	Pipe Dia. 125mm PVC	2,185 m	2,654	5,799,000		
4.6)	Pipe Dia. 150mm PVC	7,055 m	3,397	23,966,000		
4.7)	Pipe Dia. 200mm PVC	9,455 m	4,778	45,176,000		
4.8)	Pipe Dia. 250mm PVC	11,771 m	6,689	78,736,000		
4.9)	Fittings and valves	%		0		
4.10)	Extra works such as sheeting	%		0		

7)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works			9,635,250		
2.1)	Centrifugal pumps 15kW x (2+1 units)	3 nos	3,211,750	9,635,250		
3)	Building works	30 m2	55,000	1,650,000		

7)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	52,130 m	80	4,170,000		
2)	Water meter	5,213 nos	2,459	12,819,000		

7)-7 Administration building

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Administration building	1 set				

USD1 = 106.17 yen

8) FBS11

8)-1 Intake facility

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Civil works			2,000,000		
1.1) Intake facility	1 no	2,000,000	2,000,000		
2) Mechanical and Electrical works			2,066,250		
2.1) Centrifugal pumps 1.1kW x (2+1 units)	3 nos	688,750	2,066,250		
3) Building works	25 m2	70,000	1,750,000		

8)-2 Raw water transmission pipelines and Clear water transmission

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Raw water transmission pipelines and Clear water transmission			29,145,800		
1.1) Pipe Dia. 200mm PVC	6,100 m	4,778	29,145,800		

8)-3 Water treatment plant

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Civil works			36,950,000		
1.1) Coagulation and Sedimentation basin	Capacity 432 m3	50,000	21,600,000		
1.2) Filtration basin	Capacity 240 m3	50,000	12,000,000		
1.3) Treated water reservoir	Capacity 67 m3	50,000	3,350,000		
2) Mechanical and Electrical works			22,244,200		
2.1) Mechanical and Electrical works	1 set	22,244,200	22,244,200		
3) Building works			11,200,000		
3.1) Administration office	30 m2	140,000	4,200,000		
3.2) Pump station	35 m2	70,000	2,450,000		
3.3) Chemical building	40 m2	70,000	2,800,000		
3.4) Chlorinator building	25 m2	70,000	1,750,000		
3.5) Operation building of filtration basin	0 m2	55,000	0		

8)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			11,650,000		
		Capacity				
1.1)	Distribution reservoir	233 m3	50,000	11,650,000		
2)	Mechanical and Electrical works			4,145,550		
2.1)	Centrifugal pumps 5.5kW x (2+1 units)	3 nos	1,381,850	4,145,550		
3)	Building works			0		
4)	Primary distribution mains			18,154,000		
4.1)	Pipe Dia. 50mm PVC	1,923 m	1,168	2,246,000		
4.2)	Pipe Dia. 65mm PVC	0 m	1,380	0		
4.3)	Pipe Dia. 80mm PVC	0 m	1,699	0		
4.4)	Pipe Dia. 100mm PVC	2,373 m	2,230	5,292,000		
4.5)	Pipe Dia. 125mm PVC	m	2,654	0		
4.6)	Pipe Dia. 150mm PVC	3,125 m	3,397	10,616,000		
4.7)	Pipe Dia. 200mm PVC	0 m	4,778	0		
4.8)	Pipe Dia. 250mm PVC	0 m	6,689	0		
4.9)	Fittings and valves	%		0		
4.10)	Extra works such as sheeting	%		0		

8)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works					
3)	Building works					

8)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	16,670 m	80	1,334,000		
2)	Water meter	1,667 nos	2,459	4,099,000		

8)-7 Administration building

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Administration building	1 set				

USD1 = 106.17 yen

9) FBG13

9)-1 Intake facility

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Civil works			15,000,000		
1.1) Intake facility	1 no	15,000,000	15,000,000		
2) Mechanical and Electrical works			18,782,800		
2.1) Submersible pumps 7.5kW(x2) x (2+1 units)	6 nos	2,963,800	17,782,800		
2.2) Others	1 set	1,000,000	1,000,000		
3) Building works	30 m2	70,000	2,100,000		

9)-2 Raw water transmission pipelines and Clear water transmission

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Raw water transmission pipelines and Clear water transmission			112,754,900		
1.1) Pipe Dia. 300mm DCI	5,900 m	19,111	112,754,900		

9)-3 Water treatment plant

Component	Quantity	Cost (JPY)			
		Unit	Amount	Foreign Component	Local Component
1) Civil works			209,550,000		
1.1) Coagulation and Sedimentation basin	Capacity 1,860 m3	50,000	93,000,000		
1.2) Filtration basin	Capacity 1,231 m3	50,000	61,550,000		
1.3) Treated water reservoir	Capacity 1,100 m3	50,000	55,000,000		
2) Mechanical and Electrical works			107,872,000		
2.1) Mechanical and Electrical works	1 set	107,872,000	107,872,000		
3) Building works			25,400,000		
3.1) Administration office	50 m2	140,000	7,000,000		
3.2) Pump station	60 m2	70,000	4,200,000		
3.3) Chemical building	60 m2	70,000	4,200,000		
3.4) Chlorinator building	25 m2	70,000	1,750,000		
3.5) Operation building of filtration basin	150 m2	55,000	8,250,000		

9)-4 Distribution facility

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works			75,000,000		
1.1)	Distribution reservoir for B-3	Capacity 350 m3	50,000	17,500,000		
1.2)	Distribution reservoir for B-5,6,7	Capacity 1,150 m3	50,000	57,500,000		
2)	Mechanical and Electrical works			19,957,800		
2.1)	Centrifugal pumps 30kW x (2+1 units)	3 nos	6,652,600	19,957,800		
3)	Building works			0		
4)	Primary distribution mains			294,420,000		
4.1)	Pipe Dia. 50mm PVC	12,402 m	1,168	14,486,000		
4.2)	Pipe Dia. 65mm PVC	0 m	1,380	0		
4.3)	Pipe Dia. 80mm PVC	0 m	1,699	0		
4.4)	Pipe Dia. 100mm PVC	6,604 m	2,230	14,727,000		
4.5)	Pipe Dia. 125mm PVC	4,541 m	2,654	12,052,000		
4.6)	Pipe Dia. 150mm PVC	0 m	3,397	0		
4.7)	Pipe Dia. 200mm PVC	9,261 m	4,778	44,249,000		
4.8)	Pipe Dia. 250mm PVC	8,484 m	6,689	56,749,000		
4.9)	Pipe Dia. 300mm PVC	7,630 m	10,723	81,816,000		
4.10)	Pipe Dia. 350mm PVC	4,355 m	12,316	53,636,000		
4.11)	Pipe Dia. 400mm PVC	1,192 m	14,014	16,705,000		
4.12)	Fittings and valves	%		0		
4.13)	Extra works such as sheeting	%		0		

9)-5 Distribution pump station

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Civil works					
2)	Mechanical and Electrical works			8,860,950		
2.1)	Centrifugal pumps 7.5kW x (2+1 units)	3 nos	2,953,650	8,860,950		
3)	Building works	30 m2	55,000	1,650,000		

9)-6 House connection

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	House connection pipes PE	106,610 m	80	8,529,000		
2)	Water meter	10,661 nos	2,459	26,215,000		

9)-7 Administration building

	Component	Quantity	Cost (JPY)			
			Unit	Amount	Foreign Component	Local Component
1)	Administration building	1 set		14,000,000		
1.1)	Dec Phu Village	20 m2	140,000	2,800,000		
1.2)	Da Kai commune	80 m2	140,000	11,200,000		

(3) Unit Cost

(3)-1 Intake facility

a. Well Construction

Cost of sub-contract for test drilling wells (USD)	229,851.08
Number of test drilled wells	24
Unit cost of well construction (USD)	9,577
Unit cost of well construction (JPY)	1,017,000

b. Intake for river

Outline of the intake (FBG-13)
Type: Direct intake from river
Size of intake: 1.5m width
Intake channel: RC structure with stop-log and bar screen

- Estimation from Company "A"

Total cost：¥15,000,000 (including indirect cost and expensive)
- Brake down –

i) Construction work including materials: ¥12,800,000
-Shore protection （Stone mason work）
-Concrete work
-Piping work (RC pipe, 700mm)
-Screen and stop-log

ii）Temporally work（block for work space by piling）¥ 2,200,000
- Steel pile （loss cost）
- Construction by vibro-pile hammer

iii）Scouring protection work ¥1,000,000
- Steel pile
- Gabion mat (t ＝500mm）

- Estimation from Company "B"

The cost is to be ¥17,000,000 including piping work (RC pipe, 700mm).

Brake down

i)	Temporary work	¥ 5,000,000
ii)	Scouring protection work	¥ 1,500,000
iii)	Main construction work	¥ 8,000,000
iv)	Miscellaneous work	¥ 2,500,000

- Comparative cost

The adopted cost is ¥15,000,000.

Company	Company A (adopted Cost)	Company B
Total cost	15,000,000	17,000,000

c. Intake for irrigation channel

<Concrete volume>

FKS-8 and FBS-11: approx. $30m^3$

FBG-13: approx. $120m^3$

Therefore, concrete volume is about one-fourth of FBG-13.

(¥12,800,000[*1] – ¥5,000,000[*2]) / 4 = 1,950,000 = approx. ¥2,000,000

*1: Cost for construction work including materials in FBG-13

*2: Intake of FKS-8 and FBS-11 doesn't involve shore protection and piping work, because of intake from irrigation channel. Cost is assumed from result of interview from construction company.

(3)-2 Pipe

a. PVC

Table 15.1.1 Volume of Excavation and Landfill

[A1]	[A2]	[B]	[C1]	[C2]	[C3]	[D]	[E]	[F]	[G1]
Diameter (mm)	Outer diameter (mm)	Width(m)	Earth covering depth (m)	Excavation depth (m)	Excavation (m3) [B]x[C2]	Sand;10cm ,Crown;10cm (m^3) [B]x(10cm +[A2]+10cm)-pipe profile	Backfill of excavated material (m3) [C3]－ [B]x50cm	Soil transportation (m^3) [C3]-[E]	Asphalt pavement (m^2) [B] x 30% of length
50	63	0.50	0.60	0.763	0.382	0.128	0.13	0.25	0.15
65	75	0.50	0.60	0.775	0.388	0.133	0.14	0.25	0.15
80	90	0.60	0.60	0.790	0.474	0.168	0.17	0.30	0.18
100	125	0.65	0.60	0.825	0.536	0.199	0.21	0.33	0.20
125	140	0.70	0.60	0.840	0.588	0.223	0.24	0.35	0.21
150	180	0.70	0.60	0.880	0.616	0.241	0.27	0.35	0.21
200	225	0.75	0.60	0.925	0.694	0.279	0.32	0.38	0.23
250	280	0.80	0.60	0.980	0.784	0.322	0.38	0.40	0.24
300	355	0.80	0.60	1.055	0.844	0.345	0.44	0.40	0.24
350	380	1.00	0.60	1.080	1.080	0.467	0.58	0.50	0.30
400	440	1.10	0.60	1.140	1.254	0.552	0.70	0.55	0.33

Table 15.1.2 Unit Cost Per Volume of Civil Work

[A1]	[CC]	[DD]	[EE]	[FF]	[GG]
Diameter (mm)	Excavation ($/m3)	Sand + Laying ($/m3)	Backfill ($/m3) =[CC]	Soil transportation ($/m3) =[CC]x50%	Asphalt pavement ($/m2)
50	3.5	12	3.5	1.75	12
65	3.5	12	3.5	1.75	12
80	3.5	12	3.5	1.75	12
100	3.5	12	3.5	1.75	12
125	3.5	12	3.5	1.75	12
150	3.5	12	3.5	1.75	12
200	3.5	12	3.5	1.75	12
250	3.5	12	3.5	1.75	12
300	3.5	12	3.5	1.75	12
350	3.5	12	3.5	1.75	12
400	3.5	12	3.5	1.75	12

Table 15.1.3 Unit Cost Per Construction Cost

[A1]	[CCC]	[DDD]	[EEE]	[FFF]	[GGG]	[HHH]
Diameter (mm)	Excavation ($/m) [C3]x[CC]	Sand + Laying ($/m) [D]x[DD]	Backfill ($/m) [E]x[EE]	Soil transportation ($/m) [F]x[FF]	Asphalt pavement ($/m) [G1]x[GG]	Total
50	1.34	1.54	0.46	0.44	1.80	5.57
65	1.36	1.60	0.48	0.44	1.80	5.67
80	1.66	2.01	0.61	0.53	2.16	6.96
100	1.88	2.39	0.74	0.57	2.34	7.91
125	2.06	2.67	0.83	0.61	2.52	8.69
150	2.16	2.89	0.93	0.61	2.52	9.11
200	2.43	3.35	1.12	0.66	2.70	10.25
250	2.74	3.87	1.34	0.70	2.88	11.54
300	2.95	4.14	1.55	0.70	2.88	12.23
350	3.78	5.60	2.03	0.88	3.60	15.88
400	4.39	6.62	2.46	0.96	3.96	18.40

Table 15.1.4 Total Cost of Pipe Laying

Material	[A1]	[P]	[Q]	[HHH]	[R]	[X]
	Diameter (mm)	Pipe cost ($/m)	Laying cost ($/m) [HHH]x30%	Cost of earth works ($/m)	Administration cost 30%	Total
PVC	50	1.79	1.11	5.57	2.54	11.02
PVC	65	2.75	1.13	5.67	2.87	12.42
PVC	80	3.66	1.39	6.96	3.61	15.62
PVC	100	6.16	1.58	7.91	4.70	20.35
PVC	125	8.65	1.74	8.69	5.73	24.81
PVC	150	13.62	1.82	9.11	7.36	31.91
PVC	200	22.26	2.05	10.25	10.37	44.93
PVC	250	34.35	2.31	11.54	14.46	62.65
PVC	300	63.31	2.45	12.23	23.40	101.38
PVC	350	70.00	3.18	15.88	26.72	115.78
PVC	400	80.00	3.68	18.40	30.62	132.70

b. DCI

Unit cost of per meter
Conditions
1.Material: Ductile Cast Iron pipe with fittings
2. Including material and construction
3. Flow velocity: 1m/sec.

ND (mm)	$/m	JPY/m
100	70	7,432
125	80	8,494
150	90	9,555
200	120	12,740
250	150	15,926
300	180	19,111

c. PE

c-1. Number of households

Number of households is same as number of house connections.

Table 15.1.5 Number of Households in Each System

System	[1]	[2]	[1]/[2]
	population (2020)	persons/house (2006, actual)	households
FPS-2	6,856	4.0	1,714
FPS-3	13,256	4.1	3,233
FPG-4	11,666	4.0	2,890
FPS-5	9,292	4.4	2,112
FKS-6	6,626	5.3	1,243
FKS-8	6,978	5.1	1,368
FNG-10	29,715	5.7	5,213
FBS-11	7,378	4.2	1,757
FBS-13	52,241	4.9	10,661

c-2. Unit price

According to the result of interview to pipe company, unit cost of PE is 0.36USD/m and unit cost of fittings for house connection is assumed 110% of PE unit cost.

0.36 X (1.0+1.1) X 106.17= 80.3 = JPY80

d. Water meter

According to result of interview to water meter company, unit cost of water meter is 23.16USD and water meter is produced Malaysia.

23.16 X 106.17= 2,458.8 = JPY2,459

(3)-3 Building

Table 15.1.6 Building
(Past project)

No.	Building	[A]	[B1]	[B2]	[B2]÷[B1]	[B1]÷[A]	[B1+2]÷[A]
		Floor area (m2)	Building cost (JPY)	Building equipment (JPY)	Ratio (%, Equipment/ Construction)	Unit cost of building per floor area (JPY)	Unit cost of building including equipment per floor area (JPY)
1	Administration room	20	¥2,148,000	¥673,000	31%	107,400	141,050
2	Intake pump room	24	¥1,764,000	¥99,000	6%	73,500	77,625
3	Distribution pump room	27	¥1,430,000	¥33,000	2%	52,963	54,185
4	Administration room	24	¥2,260,000	¥920,000	41%	94,167	132,500
5	Intake pump room	84	¥6,458,000	¥44,000	1%	76,881	77,405
6	Distribution pump room	27	¥1,430,000	¥33,600	2%	52,963	54,207
7	Administration room	20	¥2,190,000	¥702,000	32%	109,500	144,600
8	Intake pump room	84	¥6,458,000	¥347,000	5%	76,881	81,012
9	Distribution pump room	27	¥1,430,000	¥47,237	3%	52,963	54,712
10	Administration room	24	¥2,275,000	¥952,000	42%	94,792	134,458
11	Intake pump room	36	¥2,767,000	¥148,000	5%	76,861	80,972
12	Distribution pump room	27	¥1,502,473	¥47,237	3%	55,647	57,397
13	Administration room	20	¥2,120,000	¥651,000	31%	106,000	138,550

Table 15.1.7 Unit cost of Building

No.	Building	Unit cost of building per floor area (JPY)		Unit cost of building including equipment per floor area (JPY)		Adopted cost (JPY)
		Max	Min	Max	Min	
1	Administration room	109,500	94,167	144,600	132,500	140,000
2	Intake pump room	76,881	73,500	81,012	77,405	70,000
3	Distribution pump room	55,647	52,963	57,397	54,185	55,000

(3)-4 Costs for Water Treatment Plant

In order to determine cost of water treatment plant, corrected past experience data for construction cost of water supply systems has analysis as follows;

1. Case 1: Per m^3 cost for rural water in Vietnam

The unit cost was estimated based on the data collected from each P-CERWASS of Phu Yen and Binh Thuan.

2. Case 1-1: Correction cost of case 1

Case 1-1 means correction cost of case 1 considering following conditions.

(1) The costs of samples are estimated before 5 years and the cost is corrected present including escalation cost.

(2) Considering construction work by Japanese contractor.

(3) It is corrected the cost for water treatment plant only. Because, the costs of sample are included in all facility as water supply system such as intake, water treatment and distribution net work.

3. Case 2: Per m^3 cost for urban water supply in Vietnam

Case 2 means the construction cost for urban water supply system including all equipment in Vietnam.

4. Case 2-1: Correction cost of case 2

The cost is corrected same conditions as case 1-1.

5. Case 3: Past experience of the construction cost for water treatment plant

Considering construction by Japanese contractor, the cost carve of case 3 is compared case 1-1 and case 2-1 carve.

Comparing Case 1-1

The curve of case 1-1 can not compare case 3 curve by difference of treatment system. Because, the facility of case 1-1 almost designed slow sand filter system due to small water supply capacity.

Comparing Case 2-1

The scope and system of the curve case 2-1 is almost same as curve case 3. Corrected cost curve

case 2-1 until 15,000 m^3/d of facilities capacity is approximately consistent with case 3. Therefore, case 3 curve is considered reasonable and proper to make estimation.

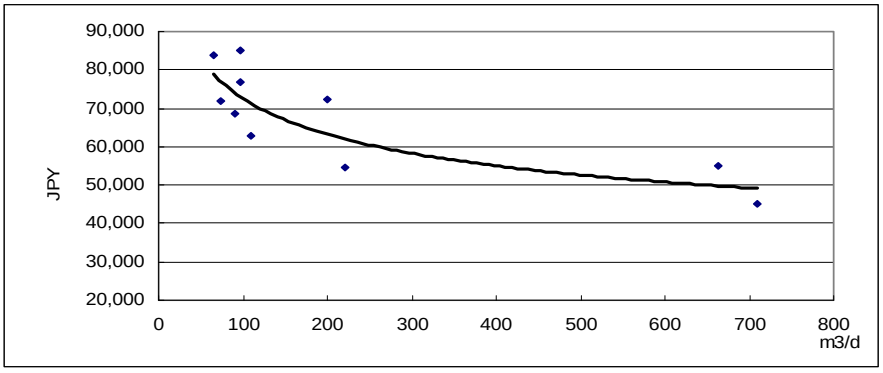
Data for Cost Estimation for Water Treatment Plant

1. Case 1: Per m^3 cost for rural water in Vietnam

Table 15.1.8 Cost VND / m^3 for Water Supply System

Cost VND/m3 for water supply system								
No.	Prov.	A: Project Name	B: Total Project Cost (million VND)	C: Pop. Served (pp)	D: Water Supply (m3/d)	E: Unit cost (x1000 VND/m3)	E: Unit cost (xyen/m3)	Correction cost *
1	PY	Hoi Son-An Hoa commune	845	1,558	73	11,575	71,695	71,139
2	PY	B Lam wss	1,334	1,076	97	13,753	85,186	84,525
3	PY	Hoa Hoi wss	885	1,113	65.5	13,511	83,687	83,038
4	PY	Duc Binh Tay wss	1,210	1,330	97.5	12,410	76,867	76,271
5	PY	Suoi Cau, Son Ha wss	1,100	909	108.5	10,138	62,794	62,308
6	PY	An Thach wss	993	1,671	89.5	11,095	68,722	68,189
7	BT	Tan Minh wss	5,885	1,747	663	8,876	54,978	54,552
8	BT	Hong Phong wss	2,331	946	200	11,655	72,191	71,631
9	BT	Hong Thais wss	5,161	398	710	7,269	45,024	44,675
10	BT	Ba Bau wss	1,935	614	220	8,795	54,476	54,054

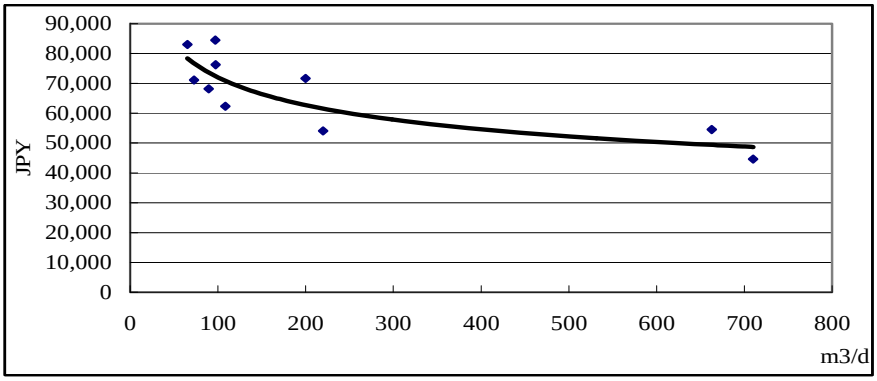
Source: P-CERWASS Phu Yen and Binh Thuan
Exchange rate Yen: VND=1:161.44



2. Case 1-1 : Correction cost of case 1

Correction cost is based on the following factors.

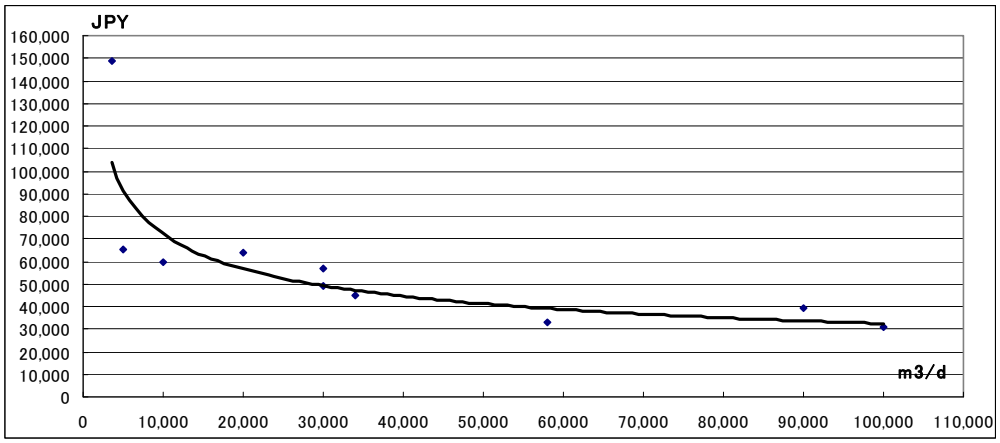
- Escalation cost: Ave.8% x 5years: (47%)
- Factor of based on Japanese market (x 1.5)
- Cost ratio: treatment plant / total cost =45%



3. Case 2 :Unit cost per m^3 for urban water supply in Vietnam

Table 15.1.9 Per m^3 Cost for Urban Water Supply in Vietnam

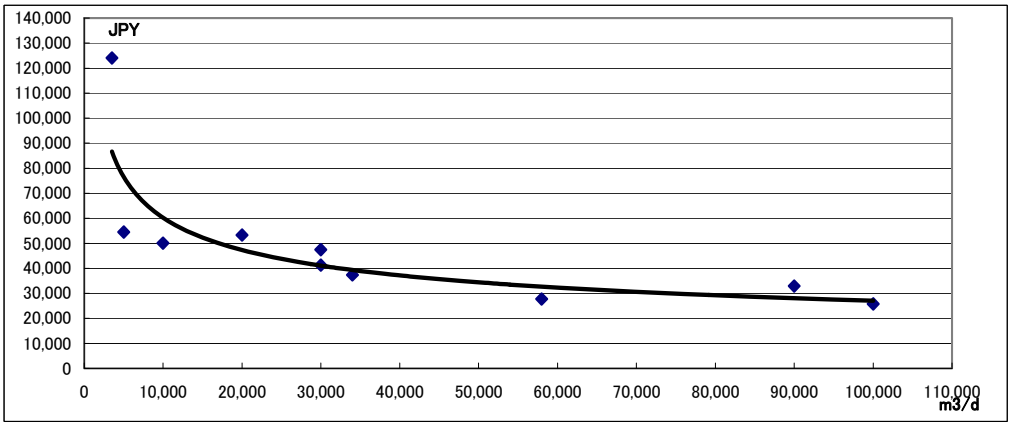
City / Town	Financed by	Cap.(m^3/d)	Cost	cost per m^3	Correction cost
Quan Ninh	WB	90,000	3,552,150,000	39,468	32,946
Hai Phong	WB	100,000	3,793,300,000	30,933	25,821
Thai Nguyen	ADB	30,000	1,482,495,000	49,417	41,250
Thanh Hoa	ADB	30,000	1,705,305,000	56,844	47,450
Nha Trang	ADB	58,000	1,927,695,000	33,236	27,744
Phan Thiet	ADB	20,000	1,278,375,000	63,919	53,356
Lon Xuyen	ADB	34,000	1,522,920,000	44,792	37,390
Ha Tinh	Vietnam government	3,500	520,000,000	148,571	124,020
Cao Bang	Vietnam government	5,000	326,666,667	65,333	54,537
Anh, Quang Ngai	Vietnam government	10,000	600,000,000	60,000	50,085



4. Case 2-1: Correction cost of case 2

Source: Ministry of Construction, 1998, Dinh Huong Phat Trien Cap Nuoc Do Thi Den Nam 2020
Correction conditions

- Escalation cost: Ave. 5 to 6% during 9years: (59%) until year 2001
- Factor of based on Japanese market (x 1.5)
- Cost ratio: treatment plant / total cost = 35% (The distribution pipe laying and intake works are more difficult than rural water supply.)

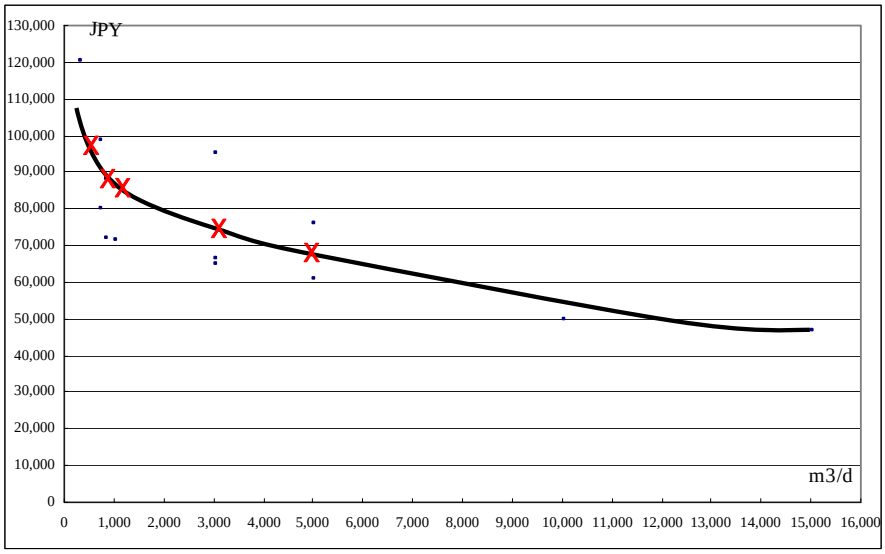


5. Case 3 : Past experience of water treatment plant

Table 15.1.10 Past Experience of Water Treatment Plant

No,	Donor	Process	Year of Est	Country /Area		Capacity (m^3/d)	cost (JPY)	cost (Yen/m3)
1	OECF	C, S, RF	1996	Indonesia	Java. Bali	700	56,000,000	80,000
2	OECF	C, S, RF	1996	Indonesia	Java. Bali	800	57,600,000	72,000
3	unclear	SF	-	Indonesia	Rural	1,000	71,700,000	71,700
4	EBRD	C,S,RF	1987	Egipt	Behera	700	69,300,000	99,000
5	EBRD	C,S,RF	1987	Egipt	Behera	800	70,400,000	88,000
6	JICA	C,S,RF	1988	Kenia	Itanga	300	36,110,000	120,367
7	JICA	SF	1992	Indonesia	Sulawesi	3,000	195,000,000	65,000
8	JICA	C,S,RF	2001	Papua New Guinea, Goroka		5,000	305,000,000	61,000
9	unclear	C,S,RF	1995	Nepal	Rural	3,000	285,000,000	95,000
10	JICA	RF	1995	Ditto	Rural	5,000	380,000,000	76,000
11	EBRD	C,S,RF	2003	Macedonia	Rural	3,000	200,000,000	66,667
12	ADB	C,S,RF	2002	Viet Nam	6 Urban cities	15,000	700,005,000	46,667
13	JICA	AT,RF	1998	Viet Nam	Hai Duon	10,000	500,000,000	50,000

Remarks
Escalation cost: 6.7% per year during 2004-2008 (IMF World economic outlook database, Oct. 2007)
Abbreviation: C: Coagration, S: Sedimentation, RF: Rapid filter. SF: Slow filter, AT: Aeration tower



According to case 3 curve, the unit per m^3 and total cost for each capacity of the system was shown in the following table.

Table 15.1.11 Capacity and Cost

System No.	Capacity (m^3/d)	Unit cost (JY)	**Total cost (JY)**
FPS-2	700	99,000	**69,512,000**
FPG-4	1,100	86,900	**95,537,500**
FNG-10	2,900	75,000	**217,495,900**
FBS-11	800	88,000	**70,394,200**
FBG-13	5,000	69,000	**342,822,000**

This cost includes mechanical, electrical, building and civil works of the treatment plant. The civil cost is estimated based on tank volume and unit cost. The building cost is estimated based on floor space and unit cost. The cost of mechanical and electrical components is calculated by reducing cost of

civil works and architectural works from total cost.

Since the process and material of system FKS-6 and FKS-8 are different compared to the case 3 curve, the electrical and mechanical equipment costs were adopted considering the lowest price offer by the Maker. The cost is expected considered to be 10% lower than the offered price.

Table 15.1.12 Mechanical and Electrical Cost

System	Offer price by Maker		**Adoption**	Note
	A	B		
FKS6	US$72,350	JY8,000,000	**JY6,913,100**	"A"x.90%
FKS8	US$331,000	JY45,000,000	**JY31,624,000**	"A"x.90%

According to the cost evaluation for system FPS-2, FPG-4, FNG-10, FBS-11 and FBG-13, the mechanical and electrical cost contributes 29% to 32% of the total cost from Table 15.1.13. It is considered reasonable and propriety in the system operated by manual.

Table 15.1.13 Cost Evaluation for Mechanical and Electrical Equipment

Water treatment plant	Cost (JPY)						
	FPS2	FPG4	FKS6	FKS8	FNG10	FBS11	FBG13
1) Total cost	**69,512,000**	**95,537,500**	**40,313,100**	**46,924,000**	**217,495,900**	**70,394,200**	**342,822,000**
2) Civil works	38,450,000	52,450,000	25,000,000	4,100,000	128,750,000	36,950,000	209,550,000
3) Mechanical and Electrical works	19,862,000	30,837,500	6,913,100	31,624,000	69,595,900	22,244,200	107,872,000
Rate= 3) / 1)	**29%**	**32%**	**17%*1)**	**67%*2)**	**32%**	**32%**	**31%**
4) Building works	11,200,000	12,250,000	8,400,000	11,200,000	19,150,000	11,200,000	25,400,000

Remarks
The system for FKS-6 and FKS-8 is singular case of the structure and process as follows;
*1): The process of the water treatment plant is slow sand filter type by concrete structure.
*2): The system is package type water treatment plant and the materials for all tanks are made from steel plate.

(3)-5 Pump

Table 15.1.14 Unit Cost of Pump

System	Commune	Location	Category	[1] Total intake flow (m^3/d)	[2] Total no. of pumps (nos)	[3] No.	[4] Operating time (hr)	[5] Intake flow/nos [1]/[2] (m^3/d)	[6] Intake flow/nos [5]/[4]/60 (m^3/m)	[7] Total head (m)	[8] Motor Power Rating (kW)	[11] Quotation (JPY)
FPS-2	P-2	Reservoir	Intake pump	700	3	1	20	350	0.29	16	1.5	493,000
		WTP	Transmission pump	600	3	1	20	300	0.25	39	3.7	635,100
FPS-3	P-4	Well	Intake pump	1200	3	1	20	400	0.33	61	5.5	1,335,450
FPG-4	P-5,6,7	River	Intake pump	1100	3	1	20	550	0.46	99	15	1,818,300
		WTP	Distribution pump P-5	556	3	1	20	278	0.23	85	5.5	1,464,500
		WTP	Transmission pump & Distribution pump P-6	376	3	1	20	188	0.16	81	3.7	1,464,500
		Distribution Reservoir	Distribution pump	164	3	1	20	82	0.07	51	1.1	785,900
FPS-5	P-8	Well	Intake pump	800	3	1	20	267	0.22	29	2.2	703,250
		WTP	Distribution pump	1600	3	1	20	800	0.67	12	2.2	1,146,950
FKS-6	K-1	Well	Intake pump	600	2	1	20	300	0.25	46	3.7	804,750
FKS-8	K-3	Well	Intake pump	403	2	1	20	202	0.17	26	2.2	703,250
		River	Transmission pump	250	3	1	20	125	0.1	12	0.5	510,400
		WTP	Distribution pump	1200	3	1	20	600	0.5	25	3.7	1,225,250
FNG-10	N-56	River	Intake pump	2900	3	1	20	1450	1.21	11	7.5	1,492,050
		WTP	Transmission & Distribution pump	4000	4	1	20	1333	1.11	72	22	3,211,750
		Pump station	Booster pump	1200	3	1	20	600	0.5	85	15	3,211,750
FBS-11	B-1	Intake	Booster pump	800	3	1	20	400	0.33	8	1.1	688,750
		WTP	Distribution pump	1400	3	1	20	700	0.58	29	5.5	1,381,850
FBG-13	B-3567	Intake	Transmission pump	5000	3	1	20	2500	2.08	13	7.5	2,963,800
		WTP	Transmission pump	4500	3	1	20	2250	1.88	53	30	6,652,600
		Pump station	Booster pump	1044	3	1	20	522	0.44	50	7.5	2,953,650

CHAPTER 16

FINANCIAL AND ECONOMIC ANALYSIS

CHAPTER 16 FINANCIAL AND ECONOMIC ANALYSIS

16.1 Study on Water Charges

First of all, the Study Team defines the WTP and ATP of water as follows;

Willingness To Pay --- The WTP generally refers to the value of water to a person as what they are willing to pay. In the Study, the WTP was estimated through the questionnaire survey "Willingness of payment for monthly usage cost (water tariff) of water supply (refer to Table 3.2.14) in the socio-economic survey conducted by the Study Team. The result indicates, thus, the maximum charge per month that water users are willing to pay for water usage in the four Provinces. According to the survey, 62.7% of the total respondents expect that monthly expenditure on water shall be less than 30,000VND.

Affordability To Pay --- The ATP was computed with reference to monthly expenditure (refer to Table 3.2.6) in the Socio-economic survey. As is usual with the water supply projects funded by the international organization such as the World Bank and the ADB, monthly expenses on water and sanitation are supposed to be between 3 to 5 % of the total expenditure of a household. In the Study, 5% shall be used for the calculation of the ATP, and then 5% of the monthly expenditure was divided with the average water consumption per household, namely 9m³, to compute the ATP/m³.

According to the result of the socio-economic survey, about 60% of total respondents replied that they have never paid any expenses on water, even in the dry season (refer to Table 3.2.7). In other words, more than half of water users in the targeted Provinces may not have any idea how much it cost. In a sense, especially in the four Provinces, it is effective to compare the WTP and ATP in order to clarify the current situation.

WTP, ATP and water charges including depreciation are calculated in the following methods;

a) WTP

	*WTP/month/Household (000VND)						**Total/ Household (000VND)	***WTP/m³ (US$)
	15	40	65	80	100	Total		
Phu Yen (# of HH)	774	252	68	34	25	1,153	27.173	0.179
(# of HH x WTP/M/HH)	11,610	10,080	4,420	2,720	2,500	31,330		
Khan Hoa (# of HH)	266	158	42	6	8	480	29.833	0.197
(# of HH x WTP/M/HH)	3,990	6,320	2,730	480	800	14,320		
Ninh Thuan (# of HH)	499	337	115	31	14	996	32.450	0.214
(# of HH x WTP/M/HH)	7,485	13,480	7,475	2,480	1,400	32,320		
Binh Thuan (# of HH)	781	343	64	28	30	1,246	27.957	0.184
(# of HH x WTP/M/HH)	11,715	13,720	4,160	2,240	3,000	34,835		

(Remarks)
* WTP/month/household confirmed in the socio-economic survey is divided into five categories as follows.

1. 15,000VND --- (median of 0 to 30,000VND)
2. 40,000VND --- (median of 30,000 to 50,000VND)
3. 65,000VND --- (median of 50,000 to 70,000VND)
4. 80,000VND --- (Although survey data shows “80,000 to 100,000VND”, this figure might be recognized as an abnormal value by measure of the result of monthly expenditure. Thus, 80,000VND shall be adopted to lessen the impact on the calculation.)
5. 100,000VND --- (Although survey data shows “more than 100,000”, same as the above reason, 100,000VND shall be adopted to lessen the impact on the calculation.)

Then, each WTP shall be multiplied by the number of household in the five categories.
(eg.) 15,000VND x 774HHs = 11,610,000VND

**Total/Household means the total WTP/month/HH shall be divided by the total number of household in the Province. It leads to the averaged WTP/HH.
(eg.) 31,330,000VND / 1,153HHs = 27,172VND

***Finally, the averaged WTP/HH is divided by the expecting water consumption per person ($9m^3$). It leads to the WTP/m^3.

- WTP/m^3 --- (WTP/HH) x 1,000 / 9 m^3 / 16,852 VND/US$
(9 m^3 = 0.06 m^3 x 5 family members/HH x 30 days)

b) ATP

	Monthly expenditure - Median (VND)	ATP/m^3* (US$)
Phu Yen	1,655,000	0.546
Khan Hoa	2,076,000	0.684
Ninh Thuan	1,733,000	0.571
Binh Thuan	2,754,000	0.908

(Remark)

* ATP/m^3 --- {(Monthly expenditure) / 16,852 VND/US$ x 5%} / 9 m^3

c) Water charges including depreciation

	Project Cost (US$)	Depreciation Cost (US$)*	Annual Consumption Amount (m^3)**	Additional Cost for Depreciation (US$) /$m^3$ ***	Proposed Tariff (US$) / m^3	Water Charge inc. Depreciation (US$) /$m^3$****
Phu Yen	8,736,400	249,611	915,202	0.273	0.255	0.528
Khan Hoa	3,141,000	89,743	290723	0.309	0.159	0.468
Ninh Thuan	10,734,100	306,689	598199	0.513	0.229	0.742
Binh Thuan	14,724,600	420,703	1258155	0.334	0.153	0.487

(Remark)

* Depreciation cost (flat rate system) --- Project cost / 35 years

** Annual Consumption Amount --- Total amount of the estimated water consumption in the targeted coverage areas in the year of 2012.

*** Additional cost for Depreciation --- Depreciation cost / Annual Consumption in the year 2012
(eg.) 249,611 / 915,202 = 0.273

**** Water Charge including Depreciation --- Additional cost for Depreciation + Proposed Tariff
(eg.) 0.273US$/$m^3$ + 0.255US$/$m^3$ = 0.528US$/$m^3$

CHAPTER 17

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

CHAPTER 17 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

17.1 Legal System concerning Environmental and Social Considerations

Construction of new water supply facilities with groundwater development and new operation works are certain to cause some effects on the natural and social environment. In general, most impacts are considered to be positive, but some might be negative and monitoring and mitigation measures would be required. Environmental and social impacts caused by the projects are identified according to their relations with existing environmental conditions at the planning sites.
In this section, the legal systems concerning the environmental and social considerations and others in Vietnam are described.

Environmental and Social Considerations in Vietnam

1) The Legal Systems of the Environmental and Social Considerations

Environmental concerns and developments of environmental legislation and policies in Vietnam began in the early 1990s. The system of the environmental impact assessment of Vietnam was provided in the "Environment Protection Law" on 1993 (defunct law) and "Providing Guidance for the Implementation of the Law on Environmental Protection" (Government Decree No. 175/CP, defunct Decree). These specify the requirements of an EIA at different stages of the project development.

However, the following problems were pointed out on environmental impact enforcement at that time.

- The definition of the object project was not clear.
- There were discordance between the law and the degree.
- In spite of having specified recognition of the EIA report as one of the requirements for project approval, many cases of irregularities were recognized after implementation of project.

Review of laws was required for solving the above issues, and the Environment Protection Law (1993) was amended as the new Environment Protection Law on November 29, 2005 that was passed by the eleventh National Assembly of the Socialist Republic of Vietnam in its eighth session. Subsequently the Decree No. 80/ 2006/ ND-CP was issued on the 9th August 2006 providing details and guidance on the implementation of a number of articles of the Environment Protection Law, and the Decree No. 140/260/ND-CP was issued on the 22nd November 2006 to provide guidance for the environmental protection at stages of elaboration, evaluation, approval and implementation of development strategies, plannings, plans, programs and projects. In the new Environment Protection Law, improvement and the strengthened point are described below compared to old Environment Protection Law.

- Introduction of Strategic Environmental Impact Assessment (SEA)
- Clear notification of projects with requirement of the Environmental Impact Assessment

- Consistency between the Law and Regulations
- Introduction of citizens' participation and information disclosure

2) Contents of Environmental and Social Considerations in Vietnam

The environmental and social considerations for implementation of Project in Vietnam consist of mainly three items that are Strategic Environmental Impact Assessment (SEA), Environmental Impact Assessment (EIA), and Environmental Protection Commitments (EPC). These environmental considerations are required according to the contents of plans and projects and its scale. Outlines of SEA, EIA and EPC are listed in Table 17.1.1 and Table 17.1.2, and flowchart of environmental and social considerations procedure is shown in Figure 17.1.1.

Table 17.1.1 Outlines of Strategic Environmental Impact Assessment (SEA) and Environmental Impact Assessment (EIA)

Item	Strategic Environmental Assessment (SEA)	Environmental Impact Assessment (EIA)
Objects	**Objects subject to elaboration of the SEA reports** • National socio-economic development strategies, plannings and plans; • Strategies, plannings and plans for development of branches or domains on national scale; • Socio-economic development strategies, planning and plans of provinces, centrally run cities (hereinafter collectively referred to as provinces or provincial level) or regions; • Planning for land use, forest protection and development; exploitation and utilization of other natural resources in inter-provincial or inter-regional areas; • Planning for development of key economic regions; • General planning of inter-provincial river watersheds. (The Environment Protection Law (EPL), Articles 14)	**Objects subject to elaboration of the EIA reports** • Projects of national importance; • Projects planned to use part of land of or exerting adverse impacts on, the natural sanctuaries, national parks, historical and cultural relic sites, natural heritages or beautiful landscapes which have been ranked; • Projects to potentially exert adverse impacts on the river watershed, coastal areas or areas of protected ecosystems; • Projects to construct new urban centers or concentrated residential areas; • Projects to exploit and use groundwater or natural resources on a large scale; • Other projects having potential risks or adverse impacts on the environment; • Projects to exploit groundwater with a capacity of 10,000m^3/day or more. (EPL, Articles 18-1, 65-1 and Decree 80/2006 /ND -CP)
Execution phase	SEA report constitutes an important content of the project and must be prepared at **the time of project formulation.** (EPL, Articles 15-2, and Decree 140/2006/ND -CP, Articles 6-1.c)	EIA reports must be elaborated simultaneously during formulation of **the Feasibility Study report of projects**. (EPL, Articles 19-2)

(Continue)

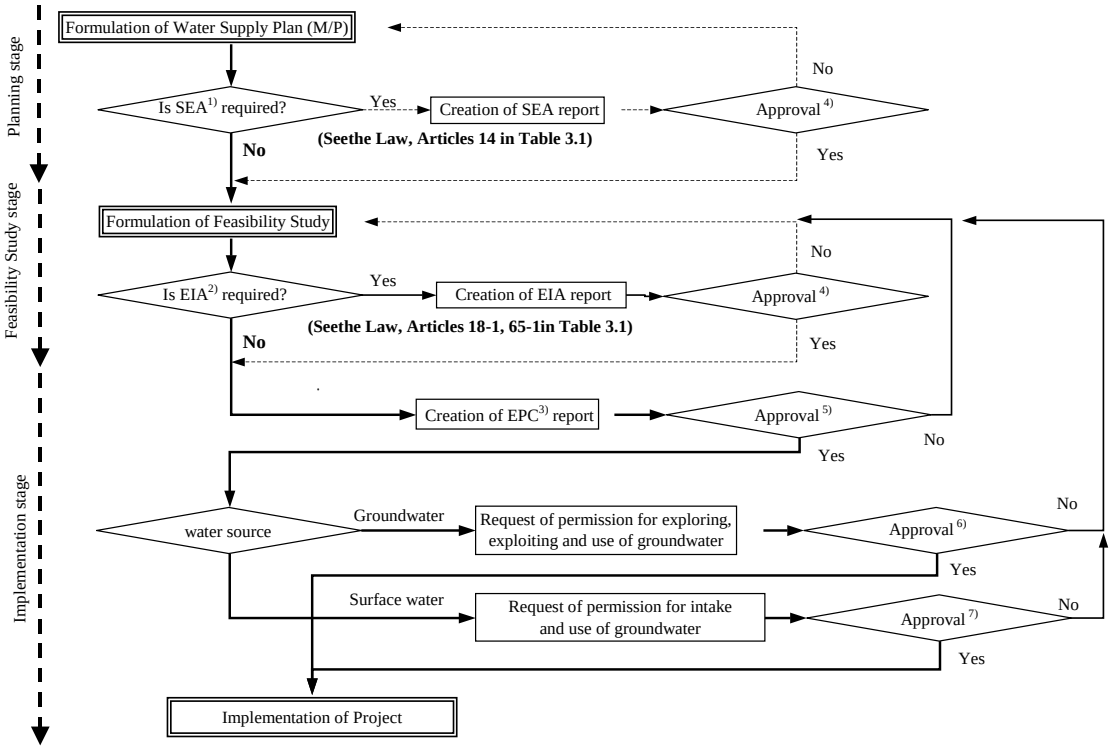
Item	Strategic Environmental Assessment (SEA)	Environmental Impact Assessment (EIA)
Contents	**Contents of the SEA reports** • Overview of the project's objectives, size and characteristics related to the environment. • General description of natural, socio-economic and environmental conditions related to the project. • Forecasts for possible negative environmental impacts when the project is executed. • Proposed orientations and measures to address environmental issues during project execution. (EPL, Articles 16)	**Contents of the EIA reports** • Enumeration and detailed description of the project • Overall assessment of the environmental status at the project site • Detailed assessment of possible environmental impacts when the project is executed. • Specific measures to minimize negative environmental impacts, and commitments to take environmental protection measures • Lists of project items, the program on management and supervision of environmental issues during project execution. • Cost estimates for establishment of environmental protection works within the total cost estimate of the project. • Opinions of the commune-level People's Committees and people in the project site must be presented in this report. (EPL, Articles 20)
Responsibilities for organizing councils	**Responsibilities for organizing councils for appraisal of the SEA reports are defined as follows:** • The Ministry of Natural Resources and Environment shall organize councils for appraisal of the SEA reports of projects subject to approval by the National Assembly, the Government or the Prime Minister; • Ministries, ministerial-level agencies or Government-attached agencies shall organize councils for appraisal of the SEA reports for projects falling under their approving competence; • Provincial-level People's Committees shall organize councils for appraisal of the SEA reports for projects falling under their deciding competence or under the competence of the People's Councils of the same level. (EPL, Articles 17-7)	**Responsibilities for organizing councils for appraisal of the EIA reports are defined as follows:** • The Ministry of Natural Resources and Environment shall organize councils or choose service organizations for appraisal of the EIA reports of projects decided or approved by the National Assembly, the Government or the Prime Minister; inter-branch or inter-provincial projects; • Ministries, ministerial-level agencies or Government-attached agencies shall organize councils or choose service organizations for appraisal of the EIA reports for projects falling under their respective deciding or approving competence, excluding inter-branch or inter-provincial projects; • Provincial-level People's Committees shall organize councils or choose service organizations for appraisal of the EIA reports for projects located in their localities and falling under their respective deciding or approving competence and under the competence of the People's Councils of the same level. (EPL, Articles 21-7)

(Continue)

Item	Strategic Environmental Assessment (SEA)	Environmental Impact Assessment (EIA)
Term of limitation for appraisal	• Projects subject to approval by the National Assembly, the Government or the Prime Minister, and project of inter-provincial or inter-sector (branches): **within 45 days** after documents receipt • Others: **within 30 days** after documents receipt (Decree 80/2006/ND-CP, Articles 12)	
Publication, conference and others	Hearing of opinions and comments from relevant province, department and agency, authority, People's committee and resident in the project site must be carried out at the time of formation of the development strategies and plans. (Decree 140/2006/ND-CP, Articles 6-1.e)	The announcement of the environmental protection measures is carried out in the project implementation site. (EPL, Articles 23-1b)

Table 17.1.2 Outlines of the Environmental Protection Commitments (EPC)

Item	Environmental Protection Commitments (EPC)
Objects	**Subjects obliged to make written environmental protection commitments** Household-based production, business or service establishments and entities not defined in Articles 14 and 18 of the Environment Protection Law i.e., project without SEA or EIA requirement must make written environmental protection commitments. (EPL, Articles 24)
Execution phase	The above-mentioned project may commence production, business or service activities after registration of written environmental protection commitments. (EPL, Articles 26-3)
Contents	**Contents of environmental protection commitments** • Location of execution. • Type and scale of production, business or service, and materials and fuel used • Kinds of generated wastes • Commitments to apply measures to minimize negative environmental impacts, and strictly comply with the provisions of law on environmental protection. (EPL, Articles 25)
Appraisal & approval	**Registration of written environmental protection commitments** 1. District-level People's Committees shall have to organize registration of written environmental protection commitments; when necessary, they may authorize this work to commune-level People's Committees. 2. The time limit for acceptance of written environmental protection commitments shall be five working days after the date of receipt of valid written commitments. (EPL, Articles 26-1,2)



Note:
1) SEA: Strategic Environmental Impact Assessment
2) EIA: Environmental Impact Assessment
3) EPC: Environmental Protection Commitments
4) Appraisal and approval in organized council by MONRE, Ministries or PCP
5) Appraisal and approval in organized council by DPC
6) Appraisal and approval by MONRE or DONRE
7) Appraisal and approval by MARD or DARD

Figure 17.1.1 Flowchart of Environmental and Social Considerations Procedure

Permission for Exploring, Exploiting and Use of Groundwater and Surface Water in Vietnam

The implementation of the EIA for water supply project with water services of 10,000 m^3/day or more is one of requirements for project authorization request, and the Environmental Protection Law obliges the formulation of EIA Report and its approval by appraisal councils or appraisal service organizations before implementation of project. In case of a small-scale rural water supply project where EIA is not necessary, the start of approval procedure requires that project owner prepares EPC and submits to district people's committee.

Similar regulations related to acquisition of permission for exploring, exploiting and use of groundwater and surface water are provided in the Law on Water Resource (No.8/1998/QH10 of May 20, 1998). According to this Law, the water supply project with groundwater and surface water development must obtain the permission for exploring, exploiting and use of groundwater and surface water before implementation of project. This is one of important requirement for project authorization. The outline of the Law on Water Resource in Vietnam is described below.

The Law on Water Resources (No.8/1998/QH10 of May 20, 1998) passed by the X^{th} National Assembly, 3^{rd} session on May 20, 1998, and the unified and comprehensive management as well as rational exploitation and stringent protection of water resources are stipulated in the Law. The main

items are shown below:

- Introduction of a management system for every river basin unit
- Introduction of approval system for exploring, exploiting and use of water sources
- State control of water resources
- Establishment of the National Water Resource Council
- Establishment of the River Basin Organization as substructure of the Ministry of Agricultural and Rural Development

Following this, a series of legal documents on the water resource protection have been promulgated, including:

- Decree No. 179/1999/ND-CP of December 30, 1999 providing for the implementation of the Water Resources Law;
- Decree No. 149/2004/ND-CP of July 27, 2004 providing for the licensing of exploration, exploitation and use of water resources and discharge of wastewater into water sources.

In the above-mentioned Decrees, it is specified that MARD and MONRE undertake duty concerning preservation of water resources. In Article 3 of the Decree No. 179/1999/ND-CP is described as follows.

< Article 3 of the Decree No. 179/1999/ND-CP>

The Ministry of Agriculture and Rural Development shall assume the prime responsibility and coordinate with the concerned ministries and branches and the People's Committees of the provinces and centrally-run cities in;

a/ Organizing the survey and assessment of deteriorated and depleted water sources;

b/ Planning the protection and development of forests in conformity with the river basin zoning in order to protect the water resources, prevent and combat flood and drought;

c/ Working out plans for restoration, upgrading, supplementary construction and renovation of water conservancy works in order to raise their water supply capability and restore the deteriorated and depleted water sources;

d/ Inspecting and supervising the exploitation and use of underground water; devising timely measures to protect underground water sources in regions and/or areas which are in danger of water reserve depletion and pollution;

e/ Inspecting and supervising places where waste water is discharged into water sources; stipulating the application of measures to treat waste water according to provisions of law.

Moreover, permission for exploring, exploiting and use of groundwater is provided in the Decree No. 149/2004/ND-CP, and its outline is presented in Table 17.1.3.

Table 17.1.3 Outline of Permission for Exploring, Exploiting and Use of Groundwater and Surface Water

Items	Description
Scope of Project	All of the project subject to permit application except following cases:

	a. Small - scale exploitation and use of surface water or underground water for daily - life household activities. b. Small - scale exploitation and use of surface water or underground water for agricultural production, forestry, aquaculture, cottage industry, hydroelectricity and other household purposes. (Decree No. 149/2004/ND – CP, Article 6-1)
Competence to issue	**The Ministry of Natural Resources and Environment** shall issue permission for exploring, exploiting underground water for projects with the flow of 3,000 m^3/day or more, and exploiting, using surface water with flow of 50,000 m^3/day or more. **The provincial - level People's Committees** shall issue permission for cases not defined above. (Decree No. 149/2004/ND – CP, Article 13)
Term and Extension of Permits	**The term of exploitation and use of permit for surface water:** It shall not exceed twenty (20) years and may be considered for extension but for not more than ten (10) years. **The term of exploration permit for groundwater:** It shall not exceed three (3) years and may be considered for extension but for not more than two (2) years. **The term of exploitation and use of permit for groundwater:** It shall not exceed fifteen (15) years and may be considered for extension but for not more than ten (10) years.

(Continue)

Items	Description
Agencies receiving and Managing Dossiers and Permits	The Department for Water Resources Management under the Ministry of Natural Resources and Environment shall be responsible for receiving and managing dossiers and permits issued by **the Ministry of Natural Resources and Environment**. The provincial/municipal Services of Natural Resources and Environment shall be responsible for receiving and managing dossiers as well as permits issued by **the provincial - level People's Committees.**
Dossier of Application	Organizations and individuals applying for **underground water** - exploration permits shall submit two (2) sets of dossier at the dossier-receiving agencies. Such a dossier shall include: a. The application for permit. b. The underground water - exploitation scheme. c. The map of the area and position of the underground water - exploitation project, of 1/50,000 - 1/25,00 scale. d. The report on the results of exploration and evaluation of underground water deposit, for projects with the flow of 200 m3/day and night; the report on the results of construction of exploitation wells, for projects with the flow of under 200 m3/day and night; the report on the current exploitation situation of operating underground water - exploitation projects. e. The results of analysis of the quality of water sources of use purposes according to the State's regulations at the time of application for the permit. f. The notarized copies of the certificate or valid papers on the right to use land where exploitation well (s) is (are) located, according to the Land Law's provisions. In cases where the exploitation well land falls beyond the land use right of the applying organizations or individual, there must be a written land - use agreement between the exploiting organization or individual and the

	organization or individual having the land use right, which must be certified by the competent People's Committee. (Decree No. 149/2004/ND – CP, Article 20) Organizations and individuals applying for **surface water** - exploitation and – use permits shall submit two (2) dossier sets at the dossier - receiving agencies. Such a dossier includes: a. The application for permit. b. The water - exploitation and - use scheme enclosed with the operation process, for cases where exploitation works are unavailable; the report on the current water - exploitation and - use situation, for cases where exploitation works already exist. c. The results of analysis of the quality of water sources for use purposes according to the State's regulations at the time of application for the permit. d. The map of the area and position of the exploitation project, of 1/50,000 - 1/25,000 scale. e. The notarized copies of the certificate of, or valid papers on, the right to use land where the exploitation work is to be located, according to the Land Law's provisions. In cases where the exploitation work land falls beyond the land use right of the applying organization or individual, there must be a written agreement on land use between the exploiting organization or individual and the organization or individual having the land use right, which must be certified by the competent People's Committee. (Decree No. 149/2004/ND – CP, Article 21)

Agrarian System in Vietnam

The agrarian system in Vietnam is governed by the following Law and five Decrees related to land.

- **Law on Land (No 13/2003/QH11)**
- Decree No. **181/2004/ND-CP** of October 29, 2004 on the implementation of the Land Law.
- Decree No. **182/2004/ND-CP** of October 29, 2004 on administrative sanctioning in the land domain.
- Decree No. **188/2004/ND-CP** of November 16, 2004 on methods to determine land prices and land price categories.
- Decree No. **197/2004/ND-CP** of December 3, 2004 on compensations, supports and resettlement upon the State recovery of land.
- Decree No. **198/2004/ND-CP** of December 3, 2004 on the collection of land use levies.

The above Government's Decrees, together with a number of guiding documents of the Ministry of Natural Resources and Environment and the Ministry of Finance, have created an important breakthrough in land management. The outline of the Law on Land (the agrarian system of Vietnam) and five Decrees is described below.

1) Land Law of Vietnam

A new Land Law was passed on November 26, 2003 by the XIth National Assembly of the Socialist Republic of Vietnam at its 4th session. It became effective on July 01, 2004.

The following items are mentioned as salient features of the agrarian system of Vietnam.

- Land is under the ownership of the entire people, and the State is the representative of the owner. The State performs uniform management of land.
- The laws of Vietnam also recognize ownership deriving from holding Land Use Rights.
- 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.

Summaries of the articles most relevant to the projects are provided below.

Table 17.1.4 Law on Land (No. 13/2003/QH11) (abstract)

No.	Description: **Law on Land (No 13/2003/QH11)**
Article-5	**Land ownership** 1. Land belongs to the entire-people with the State acting as the owner's representative. 2. The State exercises the right to dispose land as follows: a. To decide on land use purposes through deciding on, considering and approving land use plans b. To stipulate land assignment norms and land use duration; c. To decide on land assignment, land lease, land recovery, and to permit the change of land use purposes; and d. To set land prices. 3. The State shall exercise the rights regarding benefits gained from land through financial policies on land by: a) Collecting land use fees and rent; b) Collecting land use tax and income tax imposed on income from transfer of land use rights; and c) Adjusting the added value of land which is not a result of the investment of the land user. 4. The State assigns land use rights to land users in the form of land assignment, land lease, recognition of land use rights for current stable land users; and prescribes the rights and obligations of land users.

(Continue)

No.	Description: **Law on Land (No 13/2003/QH11)**
Article-6	**State management over land** 1. The State performs the uniform management of land. 2. The contents of the State management of land include: a. Promulgating legal documents on land management and use and organize the implementation thereof; b. Determining administrative boundaries, compiling and managing the administrative boundary dossiers, drawing administrative maps; c. Surveying, measuring, evaluating and categorizing land; drawing cadastral maps, land use status quo maps and land use-planning maps; d. Managing land use planning and plans; e. Managing the land use assignment, land lease, land recovery, and change of land use purposes; f. Registering land use rights, compiling and managing cadastral dossiers, and granting land use right certificates (LURC); g. Making land statistics and inventories; h. Managing land-related finance; i. Managing and developing the land use right transfer market in the real estate market; j. Managing and supervising the performance of rights and obligations of land users; k. Inspecting and examining the observance of law provisions on land and handling violations of land legislation; l. Settling land disputes; settling complaints and denunciations against violations in land

	management and use; and m. Managing land-related public service activities. 3. The State adopts policies on investment in the performance of tasks of State management over land, builds up a modern and fully capable land management system, ensuring the effective and efficient management of land.
Article-38	**Recovery of Land** The State shall recover the land in the following cases: 1. The State needs to use the land for the purposes of national defense and security, national interests, public interests, or economic development; (From 2 to 12 are omitted.)
Article-39	**Recovery of Land for the Purposes of National Defense, Security, National Interests or Public Interests** 1. The State shall carry out the land recovery, compensation and site clearance after land use zoning and land use plan has been publicly announced or where investment projects having land use demands in conformity with the land use zoning and land use plan have been approved by the competent state authorities. 2. At least ninety days prior to the recovery of agricultural land or one hundred and eighty days prior to the recovery of non-agricultural land, the competent state authorities shall notify the land users of the reasons for which the land is to be recovered; the time; the plan for movement; and the master plan for compensation, site clearance and relocation. 3. After the decision on recovery has been issued and the plan for compensation, site clearance and relocation has been approved by the competent state authorities publicly announced, and takes effects, the person whose land is recovered must comply with the decision. If the person whose land is recovered does not comply with the land recovery decision, the People's Committees which have issued such decision shall decide to enforce its decision. The person subject to the enforcement decision shall comply with the enforcement decision and have the right to make complain against such decision.

2) Procedure of Land Recovery for Public Projects

As mentioned above, as for land acquisition in the public project in Vietnam, required land for the project will be arranged under the responsibility of the state government. The procedure of land recovery for public projects is shown in Figure 17.1.2. The main point concerning this procedure is described below.

- The state shall acquire the land when the state needs to use it for the purposes of national defense and security, national interests, public interests, or economic development.
- The project owner submits a project document to the competent state authorities (province, district and commune-level people's committees), and needs to obtain approval.
- After obtaining approval, the competent state authorities establish compensation, assistance, and re-settlement council, and starts preparation of land recovery.
- At least ninety days prior to the recovery of agricultural land or one hundred and eighty days prior to the recovery of non-agricultural land, the competent state authorities shall notify the land users of the reasons for which the land is to be recovered; the time; the plan for movement; and the master plan for compensation, site clearance and relocation.
- Persons who have land recovered shall be compensated with new land having the same use purpose. 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.
- After the decision on recovery has been issued and the plan for compensation, site clearance and

relocation has been approved by the competent state authorities, it is publicly announced. This decision takes effects, and the person whose land is recovered must comply with the decision.

- If the person whose land is recovered does not comply with the land recovery decision, the people's committees which have issued such decision shall decide to enforce its decision. The person subject to the enforcement decision shall comply with the enforcement decision and have the right to lodge complain against such decision.

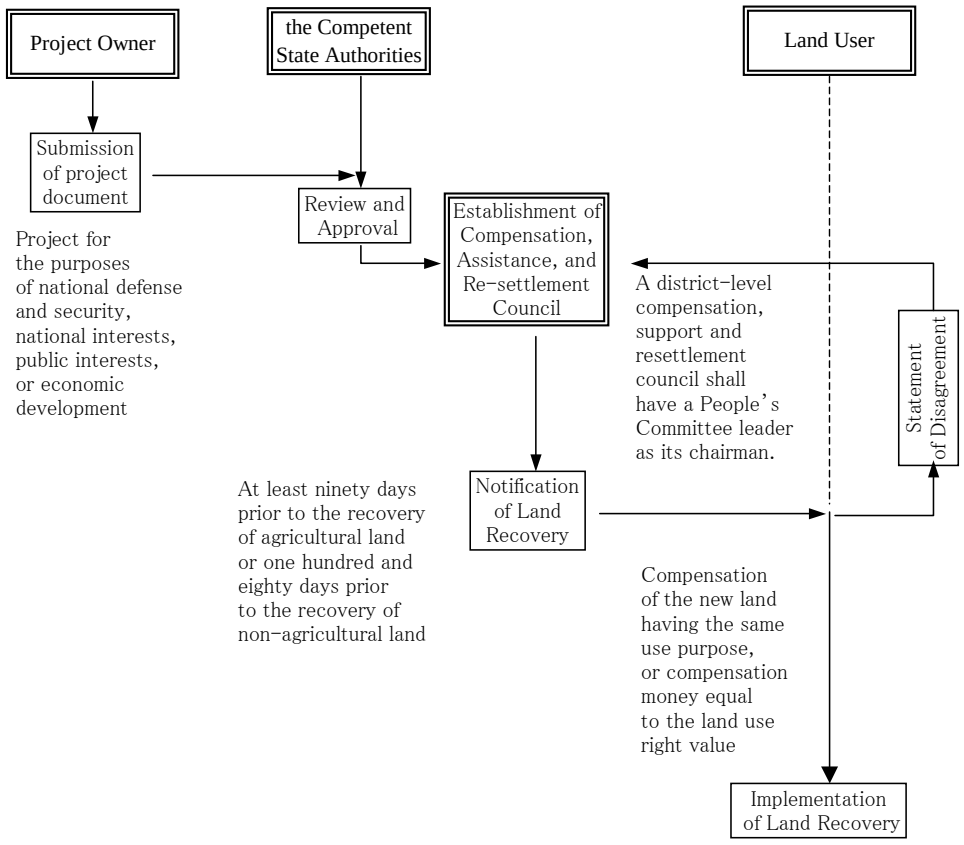


Figure 17.1.2 Procedure of Land Recovery for Public Projects

Decree 197/2004/ND-CP of December 03, 2004 provides key articles on compensation, assistance and resettlement for cases when land is recovered by the State. A summary of the articles most relevant to the project is listed below.

Table 17.1.5 Law on Land (Decree No.197/2004/ND-CP) (abstract)

No.	Description: Decree No. **197/2004/ND-CP** of December 3, 2004
Article-5	**Compensation, supports** Compensation, supports for land users who have land recovered by the State under the provisions of this Decree are prescribed as follows: 1. Compensation or supports for the whole land area recovered by the State. 2. Compensation or supports for the existing property attached to land and for expenses invested in the land recovered by the State.

	3. Supports for relocation, supports for life stabilization, supports for job change training and other supports for persons who have land recovered. 4. Supports for stabilization of production and life in the resettlement areas.
Article-6	**Compensation principles** 1. If persons whose land have land recovered been acquired by the State meet all conditions prescribed in Article 8 of this Decree, they shall receive compensation; if they fail to meet all conditions for compensation, the People's Committees of the provinces or centrally-run cities (hereinafter referred collectively to as provincial-level People's Committees) shall consider and provide supports. 2. Persons whose land have been recovered shall be compensated with new land having the same use purpose; 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; in case of compensation with new land or houses, if there is any difference in value, such difference shall be paid in cash. 3. In case of land users whose land have been recovered by the State receive compensation while they have not yet fulfilled their land-related financial obligations towards the State according to law provisions, the money amounts for fulfilling such financial obligations shall be subtracted from the compensation, support money for payment to the State budget.
Article-10	**Compensation, supports for agricultural land of households, individuals** 1. Households, individuals using agricultural land to be recovered by the State shall be compensated with land of the same use and value; if there is no such land for compensation, they shall receive monetary compensation calculated at the price of land having the same value as prescribed in Clause 1, Article 9 of this Decree. 2. For agricultural land lying intermixed with residential areas, and garden and pond land lying adjacent to residential areas, apart from compensation at the price of agricultural land having the same use purpose, monetary supports are also provided; the prices for calculation of supports shall be between 20% to 50% of the prices of adjacent residential land; the specific support levels shall be decided by the provincial-level People's Committees to suit the local realities. 3. Where compensation is made in the form of assignment of new land priced lower than the price of the recovered land, apart from being assigned new land, persons who have land recovered shall also receive monetary compensation equal to the difference in value; where compensation is made in the form of assignment of new land priced higher than the price of the recovered land, compensation shall be equal to the land use right value of the recovered land. 4. For households, individuals using agricultural land in excess of the prescribed limit, when their land is recovered, compensation shall be made as follows: a/ Where the land areas in excess of the prescribed limit are those inherited, donated or transferred from other persons, are reclaimed under the planning approved by competent State bodies, compensation shall be paid therefore; b/ For land areas in excess of the prescribed limit, which do not fall into the cases prescribed at Point "a" of this Clause, compensation shall only be paid for remaining expenses invested in land, but not for such land areas. 5. For households, individuals currently using land assigned by State-owned agricultural or forestry farms on a contractual basis being used for agricultural, forestry, aquaculture purposes (excluding land under special-use forests and protective forests), if their land is recovered by the State, they shall receive compensation only for remaining expenses invested in land, but not for the land, and supports according to the following provisions: a/ Supports for households, individuals that receive land on a contractual basis and are public employees or workers of State-owned agricultural or forestry farms, who are working or have retired, have stopped working due to loss of working capacity or have quit their jobs and enjoyed allowances and are directly engaged in agricultural production or forestry; households, individuals that receive land on a contractual basis and are directly engaged in agricultural production as their major source of livelihood. The highest level of monetary support shall be equal to the price of land to be compensated, calculated on the basis of the actually recovered land area which shall, however, not exceed the local agricultural land assignment limits; the provincial-level People's Committees shall decide on the specific support levels to suit the local realities. b/ Where households, individuals receive land on a contractual basis but are other than the subjects specified at Point "a" of this Clause, they shall only receive compensation for remaining

	expenses invested in land. c/ When agricultural land commonly used by State-owned agricultural or forestry farms is recovered by the State, compensation shall only be paid for remaining expenses invested in land if they do not originate from the State budget, but not for the land. 6. For households, individuals that use agricultural land to be recovered by the State but do not meet the conditions for compensation prescribed in Article 8 of this Decree, if they are directly engaged in agricultural production as their main source of livelihood, the People's Committees of competent levels shall consider and assign them new land, as suitable to the local conditions. 7. Where the recovered land is agricultural land belonging to the public land fund of a commune, ward or township, compensation shall not be paid for such land but the renters of such land shall receive compensation for remaining expenses invested in land.
Article-24	**Compensation for cultivated plants and reared animals** 1. The level of compensation for annual trees shall be equal to the value of the output of their crop. The value of the output of a crop shall be calculated on the basis of the productivity of the biggest crop in the last three years of the major cultivated tree in the locality and the average price at the time of land recovery. 2. The level of compensation for perennial trees shall be equal to the existing value (exclusive of the land use right value) of the orchard, calculated at the local price at the time of land recovery. 3. For unharvested crops which may be moved elsewhere, compensation for expenses for moving and for actual damage from relocation and re-planting shall be paid. 4. Forest trees planted with the source of State budget capital, natural forest trees assigned to organizations and households for growing, management, tending and protection, compensation for the value of the actual damage to the gardens shall be paid; monetary compensation shall be divided to forest managers, tenders and keepers according to law provisions on forest protection and development. 5. For reared animals (in aquaculture), compensation shall be paid as follows: a/ For reared animals that have reached the harvest time by the time of land recovery, compensation shall not be paid; b/ For reared animals that have not yet reached the harvest time by the time of land recovery, compensation shall be paid for actual damage caused by premature harvest; where they can be moved elsewhere, compensation for expenses for moving and for damage there from; the specific compensation levels shall be prescribed by the provincial-level People's Committees to suit the realities.
Article-39	**Assignment of compensation, support and resettlement tasks** 1. Basing themselves on the local realities, the provincial People's Committees shall assign the compensation, support and resettlement work to: - The compensation, support and resettlement councils of rural districts, urban districts, towns and provincial cities (collectively referred to as the district level); - Land fund development organizations. 2. A district-level compensation, support and resettlement council shall have a People's Committee leader as its chairman and the following members: - A finance agency's representative as its vice chairman; - The investor as a standing member; - A natural resources and environment agency's representative as member; - A representative of the commune-level People's Committee of the place where land is recovered as member; - One or two representatives of households having land recovered; A number of other members shall be decided by the compensation, support and resettlement council chairman to suit the local realities.
Article-43	**Responsibilities of People's Committees at all levels** 1. The provincial-level People's Committees shall have the responsibilities: a/ To direct, organize, propagate and mobilize all organizations and individuals concerning compensation, support and resettlement policies and ground clearance according to the land recovery decisions of competent State bodies; b/ To direct the provincial/municipal services, departments, branches and district-level People's Committees:

	- To draw up resettlement and resettlement area plans in service of the land recovery; - To draw up compensation, support and resettlement plans according to their competence; c/ To approve or assign the district-level People's Committees to approve compensation, support and resettlement plans; d/ To approve land prices; promulgate the property price tables for compensation calculation; prescribe support levels and supporting measures according to their competence; resettlement arrangement plans, job change training plans according to their assigned competence; e/ To direct the concerned agencies to settle citizens' complaints, denunciations related to compensation, support and resettlement according to their law-prescribed competence; f/ To guarantee impartiality and equity when considering and deciding on the compensation, support and resettlement when land is recovered by the State according to their competence prescribed in this Decree; g/ To decide or assign the district-level People's Committees to apply coercion to cases of deliberately failing to abide by the State's land recovery decisions according to their competence; h/ To direct the examination and handling of violations in the compensation, support and resettlement domain. 2. The district-level People's Committees of the places where land is recovered shall have the responsibilities: a/ To direct, organize, propagate and mobilize all organizations and individuals concerning compensation, support and resettlement policies and ground clearance according to the land recovery decisions of competent State bodies; b/ To direct the compensation, support and resettlement councils of the same level to draw up, and organize the implementation of, the compensation, support and resettlement plans; approve the compensation, support and resettlement plans according to the responsibility assignment by the provincial-level People's Committees; c/ To coordinate with the provincial/municipal services, departments and branches, organizations and investors in executing investments projects to build and plans to create resettlement areas in their localities according to the assignment of the provincial-level People's Committees; d/ To settle citizens' complaints, denunciations related to compensation, support and resettlement according to their assigned competence; issue coercive decisions and organizing coercion in the cases falling under their competence; coordinate with the functional agencies in organizing coercion according to the decisions of competent bodies. 3. The commune-level People's Committees shall have the responsibilities: a/ To organize propaganda on the land recovery purposes, compensation, support and resettlement polices of the projects; b/ To coordinate with the compensation, support and resettlement councils in certifying land and property of persons who have land recovered; c/ To join in, and create conditions for, the payment of compensation and support money to, and arrange resettlement for, persons who have land recovered, and create conditions for the ground clearance.

Some decrees and circulars are announced publicly for revision and supplement of the land law, and are listed below.

- **DECREE No. 17/2006/ND-CP**: Amending and Supplementing A Number of Articles of the Decrees Guiding the Implementation of the Land Law and Decree No. 187/2004/ND-CP on Transformation of State companies into Joint-stock companies (27 Jan. 2006)
- **DECREE No. 84/2007/ND-CP**: Additionally Stipulating the Grant of land Use Right Certificates, Recovery of Land, Exercise of Land Use Rights, Order and Procedures for Compensation, Support and Resettlement Upon land Settlement of land-Related Complaints (25 May 2007)

- **DECREE No. 123/2007/ND-CP**: Amending and Supplementing a Number of Articles of Decree No. 188/2004/ND-CP of November 16, 2004, on Methods of Determining land Prices and Price Limits of Land of Different Categories (27 Jul. 2007)
- **DECREE No. 44/2008/ND-CP**: Amending and Supplementing A Number of Articles of the Government's Decree No. 198/2004/ND-CP of December 3, 2004, on the Collection of Land Use Levels (9 Apr. 2008)
- **CIRCULAR No. 116/2004/ TT-BTC**: Guiding the Implementation of the Government's Decree No. 197/2004/ND-CP of December 3, 2004 on Compensation, Support and Resettlement when Land is Recovered by the State (7 Dec.2004)
- **CIRCULAR No. 69/2006/TT-BTC**: Amending and Supplementing the Finance Ministry's Circular No. 116/2004/TT-BTC of December 7, 2004, which Guides the Implementation of the Government's Decree No. 197/2004/ND-CP of December 3, 2004, on Compensation, support and resettlement upon Land Recover by the State (2 Aug. 2006)
- **CIRCULAR No. 05/2007/ TT-BTC**: Providing Guidance on Cases Eligible for Land Use Incentives and the Management of Land Used by Education and Training, Health, Cultural, Sports and Physical Training, Scientific and Technological, Environmental, Social, population, Family, and Children protection and care Establishments (30 May 2007)
- **CIRCULAR No. 06/2007/TT-BTNMT**: Guiding the Implementation of A Number of Articles of the Government's Decree No. 84/2007/ND-CP of May 25, 2007, Additionally Stipulating the Grant of Land Use Right Certificates, Recovery of Land Exercise of Land Use Rights, Order and Procedures for Compensation, Support and Resettlement when Land is Recovered by the State, and Settlement of Land-related Complains (2 Jul. 2007)

Drinking and Domestic Water Quality Standards and Others

List of water quality standard relevant to water supply and other standards for environmental condition are shown in Table 17.1.6. The drinking and domestic water quality standards and others are shown from Table 17.1.7 to Table 17.1.31.

Three water quality standards in Table 17.1.7 are applied as follows.

a) Drinking water hygienic standards (No. 1329/2002/BYT/QD dated April 18, 2002)

This water quality standard for drinking water is provided by Ministry of Health (MoH), and number of water quality parameters included in this standard is 112.

b) Domestic supply water quality requirements (TCVN 5502-2003)

The Vietnam standard of TCVN 5502-2003 is applied for domestic use water of water supply system in urban area, and number of water quality parameters included in this standard is 34.

c) Clean water hygienic standards (No. 09/2005/QD/BYT dated March 11, 2005)

According to the MoH's Decision No. 09/2005/QD-BYT on clean water hygienic standards, water from small-scale water supply system in rural area will be tested and monitored. Total number of water quality parameters included in this standard is 22.

Considering these points, the MoH's Decision No. 1329/2002/BYT/QD is applied as the water quality standards for drinking water. However, of total parameters defined in the standard provided by the MoH's Decision of No. 1329/2002/BYT/QD and No. 09/2005/QD-BYT, only 12 to 20 water quality parameters are considered for monitoring in water supply systems of four provinces are due to the reason described below.

- The laboratory, which can perform analysis of all the parameters of the drinking water standards, is not yet established.
- High cost is required to carry out water quality analysis of all the parameters of the drinking water standards.

On application of water quality standards for selected water supply project of the Feasibility Study, the following policies will be proposed.

a) The water quality standards of TCVN 5502-2003 (Domestic supply water quality requirements) are set as target values for water treatment facilities design.
b) The MoH's Decision No. 1329/2002/BYT/QD is applied as the water quality standards for drinking water.

However, the monitoring of water quality parameters and its frequency should be set on consultations with Department of Health in province before operation of water supply service.

Table 17.1.6 List of Drinking and Domestic Water Quality Standards and Others

Item	Name of Standards	Table No.
Drinking and domestic water quality standards	Drinking water hygienic standards (Promulgated together with the Decision of Minister of Health No 1329/2002/BYT/QD dated April 18, 2002)	Table 17.1.7
	TCVN 5502-2003 Domestic supply water quality requirements	Table 17.1.8
	Clean water hygienic standards (Issued in accordance with the Decision No 09/2005/QD/BYT Dated March 11, 2005 of Minister of Health)	Table 17.1.9
Standards related to water quality	TCVN 5942-1995 - Water quality - Quality standard of surface water	Table 17.1.10
	TCVN 5943-1995 - Water quality - Quality standard of coastal seawater	Table 17.1.11
	TCVN 5944-1995 - Water quality - Quality standard of underground water	Table 17.1.12
	TCVN 5945-1995 - Industrial waste water - Waste standard	Table 17.1.13
	TCVN 6772:2000 - Water quality - Daily-life wastewater - Permitted pollution limit	Table 17.1.14
	TCVN 6773:2000 - Water quality - Quality of water used for irrigation	Table 17.1.15
	TCVN 6774:2000 - Water quality - Quality of fresh water for protection of aquatic life	Table 17.1.16
	TCVN 6980:2001 - Water quality - Standard of industrial waste water discharged into river sections used for supply of water for daily life	Table 17.1.17
	TCVN 6981:2001 - Water quality - Standard of industrial wastewater discharged into lakes used for supply of water for daily life	Table 17.1.18
	TCVN 6982:2001 - Water quality - Standard of industrial wastewater discharged into river sections used for water sport and entertainment purposes	Table 17.1.19
	TCVN 6983:2001 - Water quality - Standard of industrial wastewater discharged into lakes used for water sport and entertainment purposes	Table 17.1.20
	TCVN 6984:2001 - Water quality - Standard of industrial wastewater discharged into river sections used for protection of aquatic life	Table 17.1.21

Item	Name of Standards	Table No.
	TCVN 6985:2001 - Water quality - Standard of industrial wastewater discharged into lakes used for protection of aquatic life	Table 17.1.22
	TCVN 6986:2001 - Water quality - Standard of industrial wastewater discharged into coastal seawater areas used for protection of aquatic life	Table 17.1.23
	TCVN 6987:2001 - Water quality - Standard of industrial wastewater discharged into coastal seawater areas used for water sport and entertainment purposes	Table 17.1.24
Standards related to air quality	TCVN 5937-1995 - Air quality - Quality Standard of Surrounding Air	Table 17.1.25
	TCVN 5938-1995 - Air quality - Permitted maximum concentrations of a number hazardous matters in surrounding air	Table 17.1.26
	TCVN 5939-1995 - Air quality - Industrial waste gas standard for dust and inorganic matters.	Table 17.1.27
	TCVN 5940-1995 - Air quality - Industrial waste gas standard for organic matters	Table 17.1.28
Standards related to noise	TCVN 5949-1998 - Acoustics - Noise in Public and Residential Areas Maximum Permitted Noise Level	Table 17.1.29
	TCVN 5948-1999 - Acoustics - Road Motor Vehicle Noise Maximum Permitted Noise Level	Table 17.1.30
Standards related to soil quality	TCVN 5941-1995 - Soil quality - Permitted maximum limit of residues of plant protection chemicals in the soil.	Table 17.1.31

Table 17.1.7 Drinking and Domestic Water Quality Standards (1)

Water Quality Standards / Items			DRINKING WATER HYGIENIC STANDARD (Promulgated together with the Decision of Minister of Health No 1329/2002/BYT/QD dated April 18, 2002)			VIETNAMESE STANDARD (TCVN) TCVN 5502: 2003 DOMESTIC SUPPLY WATER-QUALITY REQUIREMENTS			CLEAN WATER HYGIENIC STANDARD (Issued in accordance with the Decision No 09/2005/QD/BYT Dated March 11, 2005 of Minister of Health)			Guidelines for Drinking-water Quality Third Edition World Health Organization 2004, Geneva		
I. Perceptive standard and inorganic component		Color	1	15	TCU	1	15	Mg/l Pt	1	15	TCU	15	TCU	
		Taste	2	No strange taste		2	No strange taste		2	No strange taste		No strange taste		
		Turbidity	3	2	NTU	3	5	NTU	3	5	NTU	5	NTU	
		pH	4	6.5-8.5		4	6.0-8.5		4	6.0-8.5		6.5-9.5		
		Hardness	5	300	mg/l	5	300	mg/l	5	350	mg/l	500	mg/l	
		Dissolved oxygen content		-		6	6	mg/l		-		-		
		Total dissolved substance (TDS)	6	1,000	mg/l	7	1,000	mg/l	13	1,200	mg/l	1,000	mg/l	
		Aluminum content	7	0.2	mg/l	19	0.5	mg/l		-		0.2	mg/l	
		Ammonia content (NH_4^+)	8	1.5	mg/l (as N)	8	3	mg/l (as NH_4^+)	6	3	mg/l (as N)	1.5	mg/l (as N)	
		Antimony content	9	0.005	mg/l	10	0.005	mg/l		-		0.02	mg/l	
		Arsenic content	10	0.01	mg/l	9	0.01	mg/l	10	0.05	mg/l	0.01 (P)	mg/l	
		Barium content	11	0.7	mg/l		-			-		0.7	mg/l	
		Boron content (including borate and boric acid)	12	0.3	mg/l		-			-		0.5 (T)	mg/l	
		Cadmium (Cd) content	13	0.003	mg/l		-			-		0.003	mg/l	
		Chloride content	14	250	mg/l	11	250	mg/l	9	300	mg/l	250	mg/l	
		Chromium content	15	0.05	mg/l	13	0.05	mg/l		-		0.05 (P)	mg/l	1)
		Copper (Cu) content	16	2	mg/l	14	1	mg/l	14	2	mg/l	2	mg/l	2)
		Cyanide content	17	0.07	mg/l	24	0.07	mg/l	15	0.07	mg/l	0.07	mg/l	
		Fluoride content	18	0.7-1.5	mg/l	15	0.7-1.5	mg/l	16	1.5	mg/l	1.5	mg/l	3)
		Hydrogen sulfide content	19	0.05	mg/l	17	0.05	mg/l		-		0.05	mg/l	
		Iron content	20	0.5	mg/l	22	0.5	mg/l	11	0.5	mg/l	0.3	mg/l	
		Lead content	21	0.01	mg/l	12	0.01	mg/l	17	0.01	mg/l	0.01	mg/l	
		Manganese content	22	0.5	mg/l	18	0.5	mg/l	18	0.5	mg/l	0.4 (C)	mg/l	
		Mercury content	23	0.001	mg/l	23	0.001	mg/l	19	0.001	mg/l	0.001	mg/l	4)
		Molybdenum content	24	0.07	mg/l		-			-		0.07	mg/l	
		Nickel content	25	0.02	mg/l		-			-		0.02 (P)	mg/l	
		Nitrate content	26	50	mg/l (as NO_3)	20	10	mg/l (NO_3-N)	7	50	mg/l (as NO_3)	50	mg/l	5)
		Nitrite content	27	3	mg/l (as NO_2)	21	1.0	mg/l (NO_2-N)	8	3	mg/l (as NO_2)	3	mg/l	5)
		Selenium content	28	0.01	mg/l		-			-		0.01	mg/l	
		Sodium content	29	200	mg/l		-			-		200	mg/l	
		Sulphate content	30	250	mg/l		-			-		250	mg/l	
		Zinc content	31	3	mg/l	16	3	mg/l	20	3	mg/l	3	mg/l	
		Oxygenation degree (Potassium permanganate	32	2	mg/l		-		12	4	mg/l		-	
II. Organic content	a. Chlorination alkan group	Carbon tetrachloride	33	2	µg/l		-			-		0.004	mg/l	
		Dichloromethane	34	20	µg/l		-			-		0.02	mg/l	
		1,2 Dichloroethane	35	30	µg/l		-			-		0.03[b]	mg/l	
		1,1,1-Trichloroethane	36	2000	µg/l		-			-		-		
		Vinyl chloride	37	5	µg/l		-			-		0.0003[b]	mg/l	
		1,2 Dichloroethene	38	50	µg/l		-			-		0.05	mg/l	
		Trichloroethene	39	70	µg/l		-			-		0.07 (P)	mg/l	
		Tetrachloroethene	40	40	µg/l		-			-		0.04	mg/l	
	b. Hydrocarbures aromatiques	Benzene	41	10	µg/l	26	0.01	mg/l		-		0.01[b]	mg/l	
		Toluene	42	700	µg/l		-			-		0.7 (C)	mg/l	
		Xylene	43	500	µg/l		-			-		0.5 (C)	mg/l	
		Ethylbenzene	44	300	µg/l		-			-		0.3 (C)	mg/l	
		Styrene	45	20	µg/l		-			-		0.02 (C)	mg/l	
		Benzo (α) pyrene	46	0.7	µg/l		-			-		0.0007[b]	mg/l	
	c. Chlorination benzene group	Monochlorobenzene	47	300	µg/l		-			-		-		
		1,2-dichlorobenzene	48	1000	µg/l		-			-		1 (C)	mg/l	
		1,4-dichlorobenzene	49	300	µg/l		-			-		0.3 (C)	mg/l	
		Trichlorobenzene	50	20	µg/l		-			-		-		
	d. Complicated organic group	Di (2-ethylhexyl) adipate	51	80	µg/l		-			-		-		
		Di (2-ethylhexyl) phthalate	52	8	µg/l		-			-		0.008	mg/l	
		Acrylamide	53	0.5	µg/l		-			-		0.0005[b]	mg/l	
		Epichlohydrine	54	0.4	µg/l		-			-		0.0004 (P)	mg/l	
		Hexachloro butadiene	55	0.6	µg/l		-			-		0.0006	mg/l	
		Adetic acid (EDTA) Ethylendiamine tetraacetic acid	56	200	µg/l		-			-		0.6	mg/l	6)
		Nitrilotriacetic acid	57	200	µg/l		-			-		0.2	mg/l	
		Tributyl oxide	58	2	µg/l		-			-		-		

Table 17.1.8 Drinking and Domestic Water Quality Standards (2)

Items \ Water Quality Standards		DRINKING WATER HYGIENIC STANDARD (Promulgated together with the Decision of Minister of Health No 1329/2002/BYT/QD dated April 18, 2002)			VIETNAMESE STANDARD (TCVN) TCVN 5502: 2003 DOMESTIC SUPPLY WATER-QUALITY REQUIREMENTS			CLEAN WATER HYGIENIC STANDARD (Issued in accordance with the Decision No 09/2005/QD/BYT Dated March 11, 2005 of Minister of Health)			Guidelines for Drinking-water Quality Third Edition World Health Organization 2004, Geneva	
III. Botanical protection chemical	Alachlor	59	20	µg/l		-			-		0.02[b]	mg/l
	Aldicarb	60	10	µg/l		-			-		0.01	mg/l 7)
	Aldrin/dieldrin	61	0.03	µg/l		-			-		0.00003	mg/l 8)
	Atrazine	62	2	µg/l		-			-		0.002	mg/l
	Bentazone	63	30	µg/l		-			-		-	
	Carbofuran	64	5	µg/l		-			-		0.007	mg/l
	Chlordane	65	0.2	µg/l		-			-		0.0002	mg/l
	Chlorotoluron	66	30	µg/l		-			-		0.03	mg/l
	DDT	67	2	µg/l		-			-		0.001	mg/l
	1,2-Dibromo-3 Chloropropan	68	1	µg/l		-			-		0.001[b]	mg/l
	2,4-D	69	30	µg/l		-			-		0.03	mg/l 9)
	1,2-Dichloropropane	70	20	µg/l		-			-		0.04 (P)	mg/l
	1,3-Dichloropropene	71	20	µg/l		-			-		0.02[b]	mg/l
	Heptaclo and heptaclo epoxide	72	0.03	µg/l		-			-		-	
	Haxachlorobenzene	73	1	µg/l		-			-		-	
	Isoproturon	74	9	µg/l		-			-		0.009	mg/l
	Lindane	75	2	µg/l		-			-		0.002	mg/l
	MCPA	76	2	µg/l		-			-		0.002	mg/l
	Methoxychlor	77	20	µg/l		-			-		0.02	mg/l
	Metolachlor	78	10	µg/l		-			-		0.01	mg/l
	Molinate	79	6	µg/l		-			-		0.006	mg/l
	Pendimethalin	90	20	µg/l		-			-		0.02	mg/l
	Pentachlorophenol	81	9	µg/l		-			-		0.009[b] (P)	mg/l
	Permethrin	82	20	µg/l		-			-		-	
	Propanil	83	20	µg/l		-			-		-	
	Pyridate	84	100	µg/l		-			-		-	
	Simazine	85	20	µg/l		-			-		0.002	mg/l
	Trifluraline	86	20	µg/l		-			-		0.02	mg/l
	2,4 DB,	87	90	mg/l		-			-		0.09	mg/l
	Dichlorprop	88	100	µg/l		-			-		0.1	mg/l
	Fenoprop	89	9	µg/l		-			-		0.009	mg/l
	Mecoprop	90	10	µg/l		-			-		0.01	mg/l
	2,4,5-T	91	9	µg/l		-			-		0.009	mg/l
IV. Disinfection chemical and by-product	Monochloramin	92	3	µg/l		-			-		3	mg/l
	Residual chlorine	93	0.3 - 0.5	mg/l		-			-		0.5	mg/l
	Bromate	94	25	µg/l		-			-		0.01[b] (A,T)	mg/l
	Chlorite	95	200	µg/l		-			-		0.7 (D)	mg/l
	2,4,6 trichlorophenol	96	200	µg/l		-			-		0.2[b] (C)	mg/l
	Formaldehyde	97	900	µg/l		-			-		0.9	mg/l
	Bromoform	98	100	µg/l		-			-		0.1	mg/l
	Dibromochloromethane	99	100	µg/l		-			-		0.1	mg/l
	Bromodichloromethane	100	60	µg/l		-			-		0.06[b]	mg/l
	Chloroform	101	200	µg/l		-			-		0.2	mg/l
	Dichloroacetate	102	50	µg/l		-			-		0.05 (T,D)	mg/l
	Trichloroacetate	103	100	µg/l		-			-		0.2	mg/l
	Chloral hydrate	104	10	µg/l		-			-		0.01 (P)	mg/l
	Dichloroacetonitrile	105	90	µg/l		-			-		0.02 (P)	mg/l
	Dibromoacetonitrile	106	100	µg/l		-			-		0.07	mg/l
	Trichloroacetonitrile	107	1	µg/l		-			-		-	
	Xyanua chlorite (as per CN)	108	70	µg/l		-			-		-	
V. Radioactive effect level	Total activity α	109	0.1	Bq/l	33	3	pCi/l		-		0.1	Bq/l
	Total activity β	110	1	Bq/l	34	30	pCi/l		-		1	Bq/l
VI. Microorganism	Total coliform	111	0	MPN/100ml	30	2.2	MPN/100ml	21	50	MPN/100ml	0	MPN/100ml
	E. Coli or Thermotolerance	112	0	MPN/100ml	31	0	MPN/100ml	22	0	MPN/100ml	0	MPN/100ml
Others	Surface activate object, as per Linear Alkyl Benzene Sulphonate (LAS)		-		25	0.5	mg/l		-		-	
	Phenol and derivative of phenol		-		26	0.01	mg/l		-		-	
	Oil and oil compounds		-		27	0.1	mg/l		-		-	
	Organic phosphate pesticide		-		28	0.01	mg/l		-		-	
	Organic Chlorine pesticide		-		29	0.1	mg/l		-		-	

P = provisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited; T = provisional guideline value because calculated guideline value is below the level that can be achieved through practical treatment methods, source protection, etc.; A = provisional guideline value because calculated guideline value is below the achievable quantification level; D = provisional guideline value because disinfection is likely to result in the guideline value being exceeded; C = concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, leading to consumer complaints.
b: For substances that are considered to be carcinogenic, the guideline value is the concentration in drinking-water associated with an upper-bound excess lifetime cancer risk of 10-5 (one additional cancer per 100,000 of the population ingesting drinking-water containing the substance at the guideline value for 70 years). Concentrations associated with upper-bound estimated excess lifetime cancer risks of 10-4 and 10-6 can be calculated by multiplying and dividing, respectively, the guideline value by 10.

1) For total chromium
2) Staining of laundry and sanitary were may occur below guideline value
3) Volume of water consumed and intake from other sources should be considered when setting national standards
4) For total mercury (inorganic plus organic)
5) Short-term exposure
6) Applies to the free acid
7) Applies to aldicarb sulfoxide and aldicarb sulfone
8) For combined aldrin plus dieldrin
9) Applies to the free acid

Surface Water Quality Standards (TCVN 5942-1995)

1. Application scope

1.1. This standard delivers limitation of allowed parameters and allowed content of pollution substance existing in surface water.

1.2. This standard is applied to evaluate the polluted level of surface water.

2. Limit value

2.1. The list of parameters, polluting materials and limit value allowed to exist in water are given in the below table.

2.2. The method of sampling, analyzing, defining certain parameters and content are given in the Vietnam Standard equivalently.

Table 17.1.9 Surface Water Quality Standards (TCVN 5942-1995)

No.	Parameter and Substance	Unit	Limitation Value	
			A	B
1	pH value	--	6 - 8,5	5,5 - 9
2	BOD_5 (20ºC)	mg/l	<4	<25
3	COD	mg/l	<10	<35
4	Dissolved oxygen	mg/l	6	2
5	Suspended solids	mg/l	20	80
6	Arsen	mg/l	0,05	0,1
7	Barium	mg/l	1	4
8	Cadmium	mg/l	0,01	0,02
9	Lead	mg/l	0,05	0,1
10	Chromium, Hexavalent	mg/l	0,05	0,05
11	Chromium, Trivalent	mg/l	0,1	1
12	Copper	mg/l	0,1	1
13	Zinc	mg/l	1	2
14	Manganese	mg/l	0,1	0,8
15	Nickel	mg/l	0,1	1
16	Iron	mg/l	1	2
17	Mercury	mg/l	0,001	0,002
18	Tin	mg/l	1	2
19	Ammonia (as N)	mg/l	0,05	1
20	Fluoride	mg/l	1	1,5
21	Nitrate (as N)	mg/l	10	15
22	Nitrite (as N)	mg/l	0,01	0,05
23	Cyanide	mg/l	0,01	0,05
24	Phenol compounds	mg/l	0,001	0,02
25	Oil and grease	mg/l	not detectable	0,3
26	Detergent	mg/l	0,5	0,5
27	Coliform	MPN/100 ml	5000	10000
28	Total pesticides (except DDT)	mg/l	0,15	0,15
29	DDT	mg/l	0,01	0,01
30	Gross alpha activity	Bq/l	0,1	0,1
31	Gross beta activity	Bq/l	1,0	1,0

Legends:

- Column A delivers surface water which can be exploited to supply domestic water after treated as being stipulated
- Column B delivers surface water which is exploited for other purposes such as water for agriculture and fishery farming under certain stipulations

Water Quality: Coastal Water Quality Standard TCVN 5943-1995

1. Scope

1.1 This standard specifies parameter limits and allowable concentrations of pollutants in coastal water.

1.2 This standard is applied to evaluating the quality of a coastal water source.

2. Limitation Value

2.1 Parameter limits and allowable concentration of pollutants in coastal water are specified in the below table.

2.2 Standard methods of analysis of parameters and concentrations of coastal water are specified in available current TCVNs.

Table 17.1.10 Parameter Limits and Allowable Concentrations of Pollutants in Coastal Water

No.	Parameter and Substance	unit	Limitation values		
			Bathing and Recreation Area	Aquatic Cultivation Area	Others
1	Temperature	ºC	30	--	--
2	Odor		unobjectionable	--	--
3	pH value		6,5 - 8,5	6,5 - 8,5	6,5 - 8,5
4	Dissolved solid	mg/l	>or= 4	>or= 5	>or= 4
5	BOD_5 (20ºC)	mg/l	<20	<10	<20
6	Suspended solid	mg/l	25	50	200
7	Arsenic	mg/l	0,05	0,01	0,05
8	Ammonia (as N)	mg/l	0,1	0,5	0,5
9	Cadmium	mg/l	0,005	0,005	0,01
10	Lead	mg/l	0,1	0,05	0,1
11	Chromium (VI)	mg/l	0,05	0,05	0,05
12	Chromium (III)	mg/l	0,1	0,1	0,2
13	Chloride	mg/l	--	0,01	--
14	Copper	mg/l	0,02	0,01	0,02
15	Fluoride	mg/l	1,5	1,5	1,5
16	Zinc	mg/l	0,1	0,01	0,1
17	Manganese	mg/l	0,1	0,1	0,1
18	Iron	mg/l	0,1	0,1	0,3
19	Mercury	mg/l	0,005	0,005	0,01
20	Sulfide	mg/l	0,01	0,005	0,01
21	Cyanide	mg/l	0,01	0,01	0,02
22	Phenol compounds	mg/l	0,001	0,001	0,002
23	Oil and fat film	mg/l	none	none	0,3
24	Oil and fat suspension	mg/l	2	1	5
25	Total pesticides	mg/l	0,05	0,01	0,05
26	Coliform	MPN/100 ml	1000	1000	1000

Water Quality: Ground water Quality Standards TCVN 5944-1995

Table 17.1.11 Ground water Quality Standards

No.	Parameter and Pollutant	Unit	Limitation Value
1	pH value		6,5 - 8,5
2	Color	Pt - Co	5 - 50
3	Hardness (as $CaCO_3$)	mg/l	300 - 500
4	Total solids	mg/l	750 - 1500
5	Arsenic	mg/l	0,05
6	Cadmium	mg/l	0,01
7	Chloride	mg/l	200 - 600

8	Lead	mg/l	0,05
9	Chromium (VI)	mg/l	0,05
10	Cyanide	mg/l	0,01
11	Copper	mg/l	1,0
12	Fluoride	mg/l	1,0
13	Zinc	mg/l	5,0
14	Manganese	mg/l	0,1 - 0,5
15	Nitrate	mg/l	45
16	Phenol compound	mg/l	0,001
17	Iron	mg/l	1 - 5
18	Sulphate	mg/l	200 ¸ 400
19	Mercury	mg/l	0,001
20	Selenium	mg/l	0,01
21	Fecal coli	MPN/100 ml	Not detectable
22	Coliform	MPN/100 ml	3

Water Quality: Industrial Wastewater Discharge Standards TCVN 5945-1995

Table 17.1.12 Industrial Wastewater Discharge Standards

No.	Parameters and Substances	Unit	Limitation Values		
			A	B	C
1	Temperature	^oC	40	40	45
2	pH value	-	6 - 9	5,5 - 9	5 - 9
3	BOD_5 (20^oC)	mg/l	20	50	100
4	COD	mg/l	50	100	400
5	Suspended solids	mg/l	50	100	200
6	Arsenic	mg/l	0,05	0,1	0,5
7	Cadmium	mg/l	0,01	0,02	0,5
8	Lead	mg/l	0,1	0,5	1
9	Residual Chlorine	mg/l	1	2	2
10	Chromium (VI)	mg/l	0,05	0,1	0,5
11	Chromium (III)	mg/l	0,2	1	2
12	Mineral oil and fat	mg/l	Not detectable	1	5
13	Animal-vegetable fat and oil	mg/l	5	10	30
14	Copper	mg/l	0,2	1	5
15	Zinc	mg/l	1	2	5
16	Manganese	mg/l	0,2	1	5
17	Nickel	mg/l	0,2	1	2
18	Organic phosphorous	mg/l	0,2	0,5	1
19	Total phosphorous	mg/l	4	6	8
20	Iron	mg/l	1	5	10
21	Tetrachlorethylene	mg/l	0,02	0,1	0,1
22	Tin	mg/l	0,2	1	5
23	Mercury	mg/l	0,005	0,005	0,01
24	Total nitrogen	mg/l	30	60	60
25	Trichlorethylene	mg/l	0,05	0,3	0,3
26	Ammonia (as N)	mg/l	0,1	1	10
27	Fluoride	mg/l	1	2	5
28	Phenol	mg/l	0,001	0,05	1
29	Sulfide	mg/l	0,2	0,5	1
30	Cyanide	mg/l	0,05	0,1	0,2
31	Coliform	MPN/100 ml	5000	10000	--
32	Gross alpha activity	Bq/l	0,1	0,1	--
33	Gross beta activity	Bq/l	1,0	1,0	--

Water Quality: Domestic Wastewater Standards TCVN 6772-2000

1. Application scope

This standard is applied for waster water of service establishments, public works and apartment building as mentioned in Table 17.1.14 (hereinafter called as domestic waste water) when it is discharged into stipulated water area.

This standard is applied for domestic waste water at areas without treatment system only.

This standard is not applied for industrial wastewater as regulated in Vietnamese Standard 5945-1995

2. Allowed pollution limitation

Parameters and concentration of pollution compositions of domestic wastewater is not excess limitation in Table 17.1.13 when discharging into regulated areas.

Limitation levels mentioned in Table 17.1.13 are defined according to regulated analysis methods in current correlative standards.

Depending on type, scale and used area of service establishments, public works and apartment building, pollution composition limitation levels for domestic water are followed Table 17.1.14.

Table 17.1.13 Pollution Parameters and Allowed Limitation

No	Pollution parameter	Unit	Allowed limitation				
			Level 1	Level 2	Level 3	Level 4	Level 5
1	pH	mg/l	5-9	5-9	5-9	5-9	5-9
2	BOD	mg/l	30	30	40	50	200
3	Suspended solid substance	mg/l	50	50	60	100	100
4	Accumulative solid substance	mg/l	0.5	0.5	0.5	0.5	KQD
5	TDS	mg/l	500	500	500	500	KQD
6	Sulfur (per H_2S)	mg/l	1.0	1.0	3.0	4.0	KQD
7	Nitrate (NO_3^-)	mg/l	30	30	40	50	KQD
8	Oil	mg/l	20	20	20	20	100
9	Phosphate (PO_4^{3-})	mg/l	6	6	10	10	KQD
10	Total coliforms	MPN/100ml	1000	1000	5000	5000	10000
KQD: unregulated/unstipulated							

Table 17.1.14 Pollution Parameters and Allowed Limitation

No	Basic type Service and public establishment/apartment building	Used scale, area of Service and public establishment/apartment building	Allowed application level	Remark
1	Hotel	Less than 60 rooms From 60 to 200 rooms More than 200 rooms	Level 3 Level 2 Level 1	
2	Inn, guest house	10 to 50 rooms 50 to 250 rooms Over 250 rooms	Level 4 Level 3 Level 2	
3	Small hospital, health station	10 to 30 beds > 30 beds	Level 2 Level 1	Waste water must be disinfected before discharging out
4	General hospital		Level 1	Waste water must be sterilized. If there are any pollution components out of parameters mentioned in Table 17.1.13 of this standard, applying correlative limitation to those parameters regulated in Vietnamese Standard 5945-1995
5	Governmental	5.000m2 to 10.000m2	Level 3	Calculated area is working area

	organization, enterprise, foreign agency, banks, offices	10.000m2 to 50.000m2 >50.000m2	Level 2 Level 1	
6	School, research institute and similar places	5.000m2 to 25.000m2 >25.000m2	Level 2 Level 1	For specialist research institute relating to chemicals and biology, if there are any pollution components out of parameters mentioned in Table 17.1.13 of this standard, applying correlative limitation to those parameters regulated in Vietnamese Standard 5945-1995
7	General store, supper market	5.000m2 to 25.000m2 >25.000m2	Level 2 Level 1	
8	Raw food market	500m2 to 1.000m2 1.000m2 to 1.500m2 1.500m2 to 2.500m2 >2.500m2	Level 4 Level 3 Level 2 Level 1	
9	Restaurant, food store, public refectory	<100m2 100m2 to 250m2 250m2 to 500m2 500m2 to 2.500m2 >2.500m2	Level 5 Level 4 Level 3 Level 2 Level 1	Calculated area is dinning room area
10	Apartment building	<100 apartments 100 to 500 apartments >500 apartments	Level 3 Level 2 Level 1	

Water Quality: Water Quality Guidelines for Irrigation TCVN 6773-2000

1. Application scope:

This standard is applied as a guideline for evaluation of a water source quality for irrigation (hereinafter called "water irrigation") and as a foundation to manage water source quality to be suitable for purpose usage.

This standard is a foundation to choose suitable irrigation water source quality, avoiding making environmental soil and underground water polluted and degraded, and protecting crop plants.

2. Level of water quality for irrigation

Water irrigation need to have satisfactory quality with demands in Table 17.1.15.

Table 17.1.15 Water Quality for Irrigation

No.	Parameter	Unit	Level of parameter
1	Total dissolved solid substance	mg/l	< 400, using for area where has bad irrigation system, and salty soil (water's conductance, EC £ 0.75mS/cm, 25^{o}C) < 1000, using for area where has good irrigation system. (EC £ 1.75mS/cm, 25^{o}C) < 2000 and ratio of SAR (appendix A) in low water irrigation, using for area where plants can live in salty soil, good irrigation and activeness for irrigation. (EC £ 2.25mS/cm, 25^{o}C)
2	SAR ratio of water irrigation		≤ 10, using for area where has bad irrigation system. ≤ 18, using for area where has good irrigation system. > 18, using for impoverished and poor nutritious soil.
3	Bo (B)	mg/l	≤ 1, using for area where plants live are sensitive with B. ≤ 2, using for area where plants live are sensitive at average with B. ≤ 4, using for area where other plants live.

4	Dissolved oxygen	mg/l	≥ 2
5	pH	mg/l	5.5 – 8.5
6	Cl^-	mg/l	≤ 350
7	Chemical for killing grass(per each type)	mg/l	≤ 0.001
8	Hg	mg/l	≤ 0.001
9	Cadmium	mg/l	0.005 – 0.01
10	As	mg/l	0.05 – 0.1
11	Pb	mg/l	≤ 0.1
12	Cr^-	mg/l	≤ 0.1
13	Zn	mg/l	< 1, if pH (soil) ≤ 6.5 < 5, if pH (soil) > 6.5
14	Fecal coliform	MPN/ 100ml	<200 (for vegetable land and other fresh plants) No stipulation for other plants land.

Water Quality: Level of water quality for protection of aquatic lives TCVN 6774-2000

1. Limitation:

This standard is applied as a guideline for evaluation of surface water source quality to be suitable and safe for aquatic lives.

This standard is applied as a foundation to establish demands on management of water sources and protect aquatic lives.

2. Water quality for protection of aquatic lives.

To protect aquatic lives, all social economic activities have relation to waste water and exploitation, usage of surface water sources, does not cause any changes in level of parameters about water source quality differing from parameters in Table 17.1.16.

Table 17.1.16 Level of Water Quality for Protection of Aquatic Lives.

No.	Parameter	Unit	Level of parameter	Note
1	Dissolved oxygen	mg/l	5	Daily average
2	Temperature	^oC	Natural temperature of water catchment area	
3	BOD_5 (20^oC)	mg/l	< 10	Correlativeness with season
4	Chemical protection of plant (organic Cl^-) Aldrin/ Dieldrin Endrin B.H.C DDT Endosulfan Lindan Clodan Heptaclo	mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l	< 0.008 < 0.014 < 0.13 < 0.004 < 0.01 < 0.38 < 0.02 < 0.06	
5	Chemical protection of plant Organic P Parathion Malation	mg/l mg/l	0.40 0.32	
6	Herbicide 2,4 D 2,4,5 T Paraquat	mg/l mg/l mg/l	0.45 0.16 1.80	
7	CO_2	mg/l	< 12	
8	pH		6.5-8.5	

9	NH_3	mg/l	2.20 1.33 1.49 0.93	pH = 6.5; t°C = 15 pH = 8.0; t°C = 15 pH = 6.5; t°C = 20 pH = 8.0; t°C = 20
10	Cyanide	mg/l	0.005	
11	Cu	mg/l	0.002 – 0.004	Depend on hardness of $CaCO_3$
12	As	mg/l	0.02	
13	Cr^-	mg/l	0.02	
14	Cadmium	mg/l	0.08 – 1.80	Depend on hardness of H_2O
15	Pb	mg/l	0.002 – 0.007	Depend on hardness of H_2O
16	Selenium	mg/l	0.001	
17	Hg (total)	mg/l	0.10	
18	Mineral grease		No yellow scum	
19	Phenol	mg/l	0.02	
20	Dissolved solid substance	mg/l	1000	
21	Suspended solid substance	mg/l	100	
22	Surface activities agent	mg/l	0.5	

Water Quality: Standards for industrial effluents discharged into rivers using for domestic water supply TCVN 6980-2001

1. Application Scope:

This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial waste water according to discharge quantity and water flow of intake rivers.

In this standard, industrial waste water are known that solution of discharge or waste water caused by manufacturing process, processing, types of industries discharging out. The distance between outlet point and intake sources according to current regulation.

This standard is applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial waste water quality when discharging into rivers or springs (hereinafter called "river") which has water quality using for domestic water supply.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial waste water – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances according to discharge quantity when discharging into rivers which have different water flow, do not exceed correlative values in Table 17.1.17.

Parameters and concentrations of polluted substances are not mentioned in Table 17.1.17. They are applied as Vietnamese Standards 5945 – 1995.

3.2 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using other methods which jurisdictional office relating to environment assigns.

Table 17.1.17 Limitary Value on Parameters and Concentrations of Polluted Substances in Industrial Waste Water when Discharging into Rivers using for Domestic Water Supply

No.	Parameter	Q> 200 m^3/s			Q = 50 - 200 m^3/s			Q < 50 m^3/s		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1	Color, Co – Pt pH=7	20	20	20	20	20	20	20	20	20
2	Smell, sensibility	smell less	smell less	smell less	smell less	smell less	smell less	smell less	smell less	smell less
3	BOD_5 (20°C), mg/l	40	35	35	30	25	25	20	20	20

4	COD, mg/l	70	60	60	60	50	50	50	40	40
5	Total suspended solid, mg/l	50	45	45	45	40	40	40	30	30
6	As, mg/l	0.2	0.2	0.2	0.15	0.15	0.15	0.1	0.05	0.05
7	Pb, mg/l	0.1	0.1	0.1	0.08	0.08	0.08	0.06	0.06	0.06
8	Oil and mineral grease, mg/l	5	5	5	5	5	5	5	5	5
9	Grease, mg/l	20	20	20	10	10	10	5	5	5
10	Cu, mg/l	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2
11	Zn, mg/l	1	1	1	0.7	0.7	0.7	0.5	0.5	0.5
12	Total P, mg/l	10	10	10	6	6	6	4	4	4
13	Cl^-, mg/l	600	600	600	600	600	600	600	600	600
14	Coliform, MPN/100 ml	3000	3000	3000	3000	3000	3000	3000	3000	3000

Note:
Q : water flow, m^3/s
F : discharge quantity, m^3/day (24h)
50 m^3/day <= F1 < 500 m^3/day
500 m^3/day <= F2 < 5000 m^3/day
F3 >= 5000 m^3/day

Water Quality: Standards for Industrial Effluents Discharged into Lakes using for Domestic Water Supply TCVN 6981: 2001

1. Application Scope:

This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial wastewater according to discharge quantity and water flow of intake lakes.

In this standard, industrial wastewater is known that solution of discharge or wastewater caused by manufacturing process, processing, types of industries discharging out. The distance between outlet point and intake sources according to current regulation.

This standard is applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial wastewater quality when discharging into lakes (natural lakes or artificial lakes) which has water quality using for domestic water supply.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial wastewater – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances according to discharge quantity when discharging into lakes which have different water flow, do not exceed correlative parameters in Table 17.1.18

Parameters and concentrations of polluted substances are not mentioned in Table 17.1.18, they are applied as Vietnamese Standards 5945 – 1995.

3.2 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using other methods which jurisdictional office relating to environment assigns.

Table 17.1.18 Limitary Value on Parameters and Concentrations of Polluted Substances in Industrial Wastewater when Discharging into Lakes using for Domestic Water Supply

No.	Parameter	$V > 100 \times 10^6$ m^3			$V = (10 \div 100) \times 10^6$ m^3			$V < 10 \times 10^6$ m^3		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1	Color, Co – Pt pH=7	20	20	20	20	20	20	20	20	20
2	Smell, sensibility	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less
3	BOD_5 (20^{o}C), mg/l	30	30	30	20	20	20	15	15	15
4	COD, mg/l	60	60	60	40	40	40	30	30	30
5	Total suspended solid substance, mg/l	50	50	50	40	40	40	30	20	15
6	Arsenic, As, mg/l	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02
7	Pb, mg/l	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
8	Cr (III), mg/l	0.2	0.2	0.2	0.15	0.15	0.15	0.10	0.10	0.10
9	Oil and mineral grease, mg/l	5	5	5	5	5	5	5	5	5
10	Grease, mg/l	20	20	20	10	10	10	5	5	5
11	Cu, mg/l	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2
12	Zn, mg/l	1	0.8	0.8	0.7	0.7	0.7	0.5	0.5	0.5
13	Total P, mg/l	10	8	8	8	6	6	6	4	4
14	Cl^-, mg/l	500	500	500	500	500	500	500	500	500
15	Coliform, MPN/100 ml	3000	3000	3000	3000	3000	3000	3000	3000	3000

Note:
V : water flow, m^3/s
F : discharge quantity, m^3/day (24h)
50 m^3/day <= F1 < 500 m^3/day
500 m^3/day <= F2 < 5000 m^3/day
F3 >= 5000 m^3/day

Water Quality: Standards for industrial effluents discharged into rivers using for water sports and recreation TCVN 6982: 2001

1. Application Scope:

This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial waste water according to discharge quantity and water flow of intake rivers.

In this standard, industrial waste water are known that solution of discharge or waste water caused by manufacturing process, processing, types of industries discharging out. The distance between outlet point and intake sources according to current regulation.

This standard is applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial waste water quality when discharging into rivers or springs (hereinafter called ” river”) which has water quality using for swimming, recreation, games …under water.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial waste water – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances according to discharge quantity when discharging into lakes which have different water flow, do not exceed correlative parameters in Table 17.1.19.

Parameters and concentrations of polluted substances are not mentioned in Table 17.1.19, they are applied as

Vietnamese Standards 5945 – 1995.

3.2 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using other methods which jurisdictional office relating to environment assigns.

Table 17.1.19 Limitary Vvalue on Parameters and Concentrations of Polluted Substances in Industrial Wastewater when Discharging into Rivers using for Water Sports and Recreation.

No.	Parameter	Q> 200 m^3/s			Q = 50 ÷ 200 m^3/s			Q < 50 m^3/s		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1	Color, Co – Pt pH=7	20	20	20	20	20	20	20	20	20
2	Smell, sensibility	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less
3	BOD_5 (20^oC), mg/l	50	40	40	40	30	30	30	30	30
4	COD, mg/l	100	80	80	80	60	60	60	60	60
5	Total suspended solid substance, mg/l	100	90	90	90	80	80	80	70	70
6	As, mg/l	0.1	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.06
7	Pb, mg/l	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4
8	Cr (VI), mg/l	0.1	0.08	0.08	0.08	0.08	0.08	0.06	0.06	0.06
9	Total P, mg/l	10	8	8	8	6	6	6	5	5
10	Cl^-, mg/l	600	600	600	600	600	600	600	600	600
11	Coliform, MPN/100 ml	3000	3000	3000	3000	3000	3000	3000	3000	3000

Note:
Q : water flow, m^3/s
F : discharge quantity, m^3/day (24h)
50 m^3/day <= F1 < 500 m^3/day
500 m^3/day <= F2 < 5000 m^3/day
F3 >= 5000 m^3/day

Water Quality: Standards for industrial effluents discharged into lakes using for water sports and recreation TCVN 6983: 2001

1. Application Scope:

This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial waste water according to discharge quantity and water flow of intake lakes.

In this standard, industrial waste water are known that solution of discharge or waste water caused by manufacturing process, processing, types of industries discharging out. The distance between outlet point and intake sources according to current regulation.

This standard is applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial waste water quality when discharging into lakes (natural lakes or artificial lakes) which has water quality using for swimming, recreation, games… under water.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial waste water – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances according to discharge quantity when discharging into lakes which have different water flow, do not exceed correlative parameters in Table 17.1.20.

Parameters and concentrations of polluted substances are not mentioned in Table 17.1.20, they are applied as Vietnamese Standards 5945 – 1995.

3.2 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using other methods which jurisdictional office relating to environment assigns.

Table 17.1.20 Limitary Value on Parameters and Concentrations of Polluted Substances in Industrial Wastewater when Discharging into Lakes using for Water Sports and Recreation.

No.	Parameter	$V > 100 \times 10^6$ m^3			$V = (10 \div 100) \times 10^6$ m^3			$V < 10 \times 10^6$ m^3		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1	Color, Co – Pt pH=7	50	50	50	50	50	50	50	50	50
2	Smell, sensibility	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less	Smell less
3	BOD_5 (20^oC), mg/l	50	40	40	30	30	30	30	20	20
4	COD, mg/l	100	80	80	70	60	60	60	40	40
5	Total suspended solid substance, mg/l	80	80	80	70	70	60	60	50	50
6	As, mg/l	0.1	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.06
7	Pb, mg/l	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.1
8	Cr (III), mg/l	0.1	0.08	0.08	0.08	0.08	0.08	0.06	0.06	0.06
9	Total P, mg/l	8	6	6	6	5	5	5	4	4
10	Hg, mg/l	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004
11	Cl^-, mg/l	500	500	500	500	500	500	500	500	500
12	Coliform, MPN/100 ml	3000	3000	3000	3000	3000	3000	3000	3000	3000

Note:
V : water flow, m^3/s
F : discharge quantity, m^3/day (24h)
50 m^3/day <= F1 < 500 m^3/day
500 m^3/day <= F2 < 5000 m^3/day
F3 >= 5000 m^3/day

Water Quality: Standards for Industrial Effluents Discharged into Rivers using for Protection of Aquatic Life. TCVN 6984: 2001

1. Application Scope:

This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial wastewater according to discharge quantity and water flow of intake rivers.

In this standard, industrial wastewater is known that solution of discharge or wastewater caused by manufacturing process, processing, types of industries discharging out. The distance between outlet point and intake sources according to current regulation.

This standard is applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial wastewater quality when discharging into rivers or springs with detail (hereinafter called “river”) that has water

quality is used for protection of aquatic life.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial waste water – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances in wastewater according to discharge quantity when discharging into rivers which have different water flow, do not exceed correlative parameters in Table 17.1.21.

Parameters and concentrations of polluted substances are not mentioned in Table 17.1.21, they are applied as Vietnamese Standards 5945 – 1995.

3.2 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using different methods which jurisdictional office relating to environment assigns.

Table 17.1.21 Limitary Value on Parameters and Concentrations of Polluted Substances in Industrial Wastewater when Discharging into Rivers using for Protection of Aquatic Life.

No.	Parameter	Q > 200 m^3/s			Q = 50 ÷ 200 m^3/s			V < 50 m		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1	Color, Co – Pt pH=7	50	50	50	50	50	50	50	50	50
2	Smell, sensibility	light	light	light	light	light	light	light	light	light
3	Total indecisive solid substance, mg/l	100	100	100	90	80	80	80	80	80
4	pH	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5
5	BOD_5 (20°C), mg/l	50	45	40	40	35	30	30	20	20
6	COD, mg/l	100	90	80	80	70	60	60	50	50
7	As, mg/l	0.1	0.1	0.1	0.08	0.08	0.08	0.05	0.05	0.05
8	Cd, mg/l	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
9	Pb, mg/l	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
10	Fe, mg/l	5	5	5	4	4	4	3	3	3
11	CN^-, mg/l	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.05
12	Oil and mineral grease	10	5	5	10	5	5	5	5	5
13	Oil and grease, mg/l	20	20	20	20	10	10	10	10	10
14	P (organic), mg/l	1	1	0.8	0.8	0.5	0.5	0.5	0.5	0.5
15	Total P, mg/l	10	8	8	6	6	6	5	5	4
16	Cl^-, mg/l	1000	1000	1000	800	800	800	750	750	750
17	Surface activities agent	10	10	10	5	5	5	5	5	5
18	Coliform, MPN/100 ml	5000	5000	5000	5000	5000	5000	5000	5000	5000
19	PCB, mg/l	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01

Note:
Q : water flow, m^3/s
F : discharge quantity, m^3/day (24h)
50 m^3/day <= F1 < 500 m^3/day
500 m^3/day <= F2 < 5000 m^3/day
F3 >= 5000 m^3/day

Water Quality: Standards for Industrial Effluents Discharged into Lakes using for Protection of Aquatic Life TCVN 6985: 2001

1. Application Scope:

This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial waste water according to discharge quantity and water quantity of intake lakes.

In this standard, industrial waste water are known that solution of discharge or waste water caused by manufacturing process, processing, types of industries discharging out.

This standard is applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial waste water quality when discharging into lakes (natural or artificial) which used for protection of aquatic life.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial waste water – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances in waste water according to discharge quantity when discharging into lakes do not exceed correlative parameters in Table 17.1.22. Parameters and concentrations of polluted substances are not mentioned in Table 17.1.22, they are applied as Vietnamese Standards 5945 – 1995.

3.2 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using other methods which jurisdictional office relating to environment assigns.

Table 17.1.22 Limitary Value on Parameters and Concentrations of Polluted Substances in Industrial Waste Water when Discharging into Lakes using for Protection of Aquatic Life.

No.	Parameter	V > 100 x 10^6 m^3			V = (10- 100) x 10^6 m3			V < 10 x 10^6 m^3		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1	Color, Co – Pt pH=7	50	50	50	50	50	50	50	50	50
2	Smell, sensibility	light	light	light	light	light	light	light	light	light
3	Total indecisive solid substance, mg/l	100	92	90	80	70	70	70	70	70
4	pH	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5
5	BOD_5 (20^oC), mg/l	50	40	40	40	30	30	30	20	20
6	COD, mg/l	90	80	80	70	60	60	50	50	50
7	Arsenic, As, mg/l	0.1	0.07	0.07	0.05	0.05	0.04	0.04	0.03	0.03
8	Cadmium, Cd, mg/l	0.02	0.15	0.15	0.01	0.01	0.01	0.05	0.01	0.01
9	Pb, mg/l	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.1	0.1
10	Fe, mg/l	5	5	5	4	4	4	3	3	3
11	CN^-, mg/l	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.05
12	Oil and mineral grease	10	10	10	5	5	5	5	5	5
13	Oil and grease, mg/l	10	10	10	7	7	7	5	5	5
14	P (organic), mg/l	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3
15	Total P, mg/l	6	6	6	5	5	5	4	4	4
16	Cl^-, mg/l	750	750	700	650	600	600	500	500	500
17	Free Cl^-, mg/l	1	1	1	1	1	1	1	1	1
18	Surface activities agent	5	5	5	5	5	5	5	5	5
19	Coliform, MPN/100 ml	5000	5000	5000	5000	5000	5000	5000	5000	5000
20	PCB, mg/l	0.05	0.04	0.04	0.04	0.03	0.03	0.01	0.01	0.01

Note:
Q : water flow, m^3/s
F : discharge quantity, m^3/day (24h)
50 m^3/day <= F1 < 500 m^3/day
500 m^3/day <= F2 < 5000 m^3/day
F3 >= 5000 m^3/day

Water Quality: Standards for Industrial Effluents Discharged into Coastal water using for protection of aquatic life TCVN 6986: 2001

1. Application Scope:

This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial waste water according to discharge quantity.

In this standard, industrial waste water are known that solution of discharge or waste water caused by manufacturing process, processing, types of industries discharging out . The distance between outlet point and intake sources according to current regulation.

This standard is applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial waste water quality when discharging into coastal water which has water quality is used for protection of aquatic life.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial wastewater – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances according to discharge quantity when discharging into coastal water which do not exceed correlative parameters in Table 17.1.23.

Parameters and concentrations of polluted substances are not mentioned in Table 17.1.23, they are applied as Vietnamese Standards 5945 – 1995.

3.2 If coastal water area has coral ecosystem or another ecosystem which it is sensitive about temperature waste water discharging into this area do not make temperature increase in coastal area where receiving waste water is over 3^oC, measuring is 100m far from waste water intake place and in spreading area of waste water.

3.3 Waste water consists of biphenin polychlorin (PCB), poliacromat hydrocacbon (PAH) discharging into coastal water area only with low level by current analysis.

Do not discharge waste water consisting of radioactive substance, inflammable solvent, suspended solid matter's dimension is more than 1 mm into coastal water area

3.4 National jurisdiction office or local jurisdiction office has coastal water area, can stipulate the limitation, concentrations and parameters in Table 17.1.23 strictly upon objectives and demands on protection of environmental sea.

3.5 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using other methods which jurisdictional office relating to environment assigns.

Table 17.1.23 Limitary Value on Parameters and Concentrations of Polluted Substances in Industrial Wastewater when Discharging into Coastal Water using for Protection of Aquatic Life.

No.	Parameter	Allowed Limitation		
		F1	F2	F3
1	Color- Pt, pH = 7	50	50	50
2	Smell, sensibility	Smell less	Smell less	Smell less
3	Suspended solid substance, mg/l	100	80	50
4	pH	5-9	5-9	5-9
5	BOD_5 (20^0C), mg/l	50	20	10
6	COD, mg/l	100	80	50
7	As, mg/l	1	0.5	0.1
8	Pb, mg/l	1	0.5	0.5
9	Cr (VI), mg/l	1	0.5	0.1
10	Cu, mg/l	1	0.5	0.1
11	Zn, mg/l	2	1	1
12	Mn, mg/l	5	5	1
13	Hg, mg/l	0.005	0.001	0.001
14	Total Nitrogen (N), mg/l	20	15	10
15	Oil and mineral grease, mg/l	10	5	5
16	Grease, mg/l	30	20	10

17	Organic P, mg/l	0.5	0.2	0.2
18	Surface activities agent	10	5	5
19	Coliform, MPN/100 ml	5000	5000	5000
Note: F : discharge quantity, m^3/day (24h) 50 m^3/day <= F1 < 500 m^3/day 500 m^3/day <= F2 < 5000 m^3/day F3 >= 5000 m^3/day				

Water Quality: Standards for industrial effluents discharged into coastal water using for protection of aquatic life TCVN 6987: 2001

1. Application Scope:

1.1 This standard stipulates the detail of limitary value on parameters and concentrations of polluted substances in industrial waste water according to discharge quantity.
In this standard, industrial waste water are known that solution of discharge or waste water caused by manufacturing process, processing, types of industries discharging out. The distance between outlet point and intake sources according to current regulation.

1.2 This standard applied as well as Vietnamese Standards 5945: 1995 and is used for controlling industrial waste water quality when discharging into coastal water which has water quality is used for swimming, recreation, games… under water.

2. Quotation standards

Vietnamese Standards 5945: 1995 Industrial waste water – Discharge Standards

3. Limitary value

3.1 Limitary value on parameters and concentrations of polluted substances according to discharge quantity when discharging into coastal water area which do not exceed parameters in Table 17.1.24.
Parameters and concentrations of polluted substances are not mentioned in Table 17.1.24, they are applied as Vietnamese Standards 5945 – 1995.

3.2 Waste water consists of biphenin polychlorin (PCB), poliacromat hydrocacbon (PAH) discharging into coastal water area only with low level by current analysis.
Do not discharge waste water consisting of radioactive substance, inflammable solvent, suspended solid matter's dimension is more than 1 mm into coastal water area.

3.3 Method of taking sample, analyzing, calculating, defining each detailed parameter and concentration is stipulated in correlative Vietnamese Standards or using other methods which jurisdictional office relating to environment assigns.

Table 17.1.24 Limitary Value on Parameters and Concentrations of Polluted Substances in Industrial Wastewater when Discharging into Coastal Water using for Water Sport and Recreation

No.	Parameter	Allowed Limitation		
		F1	F2	F3
1	Temperature, ^oC	50	50	50
2	Smell, sensibility	Smell less	Smell less	Smell less
3	Color, Pt, pH = 7	30	30	30
4	Suspended solid substance, mg/l	100	80	60
5	pH	5.5 - 8.5	5.5 – 8.5	5.5 – 8.5
6	BOD_5, mg/l	50	40	30
7	COD, mg/l	100	80	50
8	As, mg/l	1	0.5	0.1
9	Pb, mg/l	0.5	0.4	0.4
10	Cr (VI), mg/l	1	0.5	0.1
11	F^-, mg/l	25	25	15

12	Hg, mg/l	0.005	0.004	0.004
13	S, mg/l	1	0.5	0.5
14	Total Nitrogen (N), mg/l	20	15	10
15	Total P, mg/l	6	5	4
16	Oil and mineral grease, mg/l	5	5	5
17	Grease	10	10	10
18	Surface activities agent	10	5	5
19	Coliform, MPN/100 ml	3000	3000	3000

Note:
F : discharge quantity, m^3/day (24h)
50 m^3/day <= F1 < 500 m^3/day
500 m^3/day <= F2 < 5000 m^3/day
F3 >= 5000 m^3/day

Air Quality: Ambient Air Quality Standards TCVN 5937-1995

1. Scope

1.1 This standard specifies concentration limits of main constituents in ambient air (carbon monoxide nitrogen dioxide, ozone, sulfur dioxide, Lead particulate, suspended particles).

1.2 This standard applied to evaluation of ambient air quality and to monitoring of air pollution status.

2. Limitation Values

The limits of main parameters in ambient air are shown in Table 17.1.25.

Table 17.1.25 Ambient Air Quality Standards

No.	Parameter	1 hr- Averaging Time	8 hr-Averaging Time	24 hr-Averaging Time
1	CO	40	10	5
2	NO_2	0,4	-	0,1
3	SO_2	0,5	-	0,3
4	Lead (particulate)	-	-	0,005
5	O_3	0,2	-	0,06
6	Suspended particulate matter	0,3	-	0,2

Note: Standard methods of analysis of ambient air quality parameters are specified in available current TCVNs.

Air Quality: maximum Allowable Concentration of Hazards Substances in Ambient Air TCVN 5938-1995

1. Scope

1.1 This standard specifies maximum allowable concentration of some organic and inorganic hazardous substances in ambient air.

1.2 This standard is applied to evaluation of ambient air quality and to monitoring of ambient air pollution status.

1.3 This standard is not applicable to the workplace air quality.

2. Limitation Values

Maximum allowable concentrations of the hazardous substances in ambient air are shown in Table 17.1.26.

Table 17.1.26 Maximum Allowable Concentrations of Some Hazardous Substances in Ambient Air (mg/m^3)

No.	Substances	Chemical Formula	Average over 24hrs	Maximum One Occasion
1	Acrylonitrile	CH_2=CHCN	0,2	-
2	Ammonia	NH_3	0,2	0,2
3	Aniline	$C_6H_5NH_2$	0,03	0,05

4	Anhydrious vanadium	V_2O_5	0,002	0,05
5	Arsenic (inorganic compound, as As)	As	0,003	-
6	Hydrogen arsenic	AsH_3	0,002	-
7	Acetic acid	CH_3COOH	0,06	0,2
8	Hydrochloric acid	HCl	0,06	-
9	Nitric acid	HNO_3	0,15	0,4
10	Sulfuric acid	H_2SO_4	0,1	0,3
11	Benzene	C_6H_6	0,1	1,5
12	Particles containing SiO_2			
	- dianas 85-90% SiO_2		0,05	0,15
	- diatomic brick 50% SiO_2		0,1	0,3
	- cement 10% SiO_2		0,1	0,3
	- dolomite 8% SiO_2		0,15	0,5
13	Particles containing asbestos		none	none
14	Cadmium (metal and oxide) as Cd	Cd	0,001	0,003
15	Carbon disulfide	CS_2	0,005	0,03
16	Carbon tetrachloride	CCl_4	2	4
17	Chloroform	$CHCl_3$	0,02	-
18	Tetraethyl lead	$Pb(C_2H_5)_4$	none	0,005
19	Chlorine	Cl_2	0,03	0,1
20	Benzidine	$NH_2C_6H_4C_6H_4NH_2$	none	none
21	Chromium-metal and compound	Cr	0,0015	0,0015
22	1,2 -Dichlorethane	$C_2H_4Cl_2$	1	3
23	DDT	$C_8H_{11}Cl_4$	0,5	-
24	Hydrogen fluoride	HF	0,005	0,02
25	Formaldehyde	HCHO	0,012	0,012
26	Hydrogen sulfide	H_2S	0,008	0,008
27	Hydrogen cyanide	HCN	0,01	0,01
28	Manganese and compound (as MnO_2)	Mn/MnO_2	0,01	-
29	Nickel (metal and compound)	Ni	0,001	-
30	Naphthalene		4	-
31	Phenol	C_6H_5OH	0,01	0,01
32	Styrene	$C_6H_5CH=CH_2$	0,003	0,003
33	Toluene	$C_6H_5CH_3$	0,6	0,6
34	Trichloroethylene	$ClCH=CCl_2$	1	4
35	Mercury (metal and compound)	Hg	0,0003	--
36	Vinylchloride	$ClCH=CH_2$	-	13
37	Gasoline		1,5	5,0
38	Tetrachloroethylene	C_2Cl_4	0,1	-

Note: Standard analysis methods of concentration of the substances are specified in available current TCVNs.

Air Quality: Industrial Emission Standards Inorganic Substances and Matters

TCVN 5939-1995

1. Scope

1.1 This standard specifies the maximum allowable concentration (in mg/m3 of emission gas) of inorganic substances and dusts in industrial emission gases emitted into the ambient air.
In this standard, **Industrial emission gas** means: smoke, gas, dust, or gases or smokes containing dusts, particulate or inorganic substances produced by sources of any industrial process, or by sources of any servicing and trading activity, or by other activities.

1.2 This standard is applied to control of concentrations of industrial emission gases before being emitted into atmosphere.

2. Limitation Values

2.1 Maximum concentration of the inorganic substances and dusts in industrial emission gases emitted by any source into atmosphere should be compliant with the values shown in Table 17.1.27.

2.2 The limit values of concentrations of inorganic substances, particulate and dusts specified in the **column A** are applied to the emission gases of existing sources, in **column B** are applied to all sources imposed from the date which stated by environmental authority.

2.3 The limit values of concentrations of substances and dusts in emission gases or smokes created by particular sources (e.g. cement production, oil refinery, vehicle exhaust, etc.) are specified in separate standards.

Table 17.1.27 Maximum Allowable Concentration (MAC) of Smokes, Dusts and Inorganic Substances in the Industrial Emission Gases

No.	Parameter	MAC (mg/m^3)	
		A	B
1	Particulate in smoke of:		
	- heating of metals	400	200
	- asphalt concrete plant	500	200
	- cement plant	400	100
	- other sources	600	400
2	Dust		
	- containing silica	100	50
	- containing asbestos	none	none
3	Antimony	40	25
4	Arsenic	30	10
5	Cadmium	20	1
6	Lead	30	10
7	Copper	150	20
8	Zinc	150	30
9	Chloride	250	20
10	HCl	500	200
11	Fluoride, HF (any source)	100	10
12	H_2S	6	2
13	CO	1,500	500
14	SO_2	1,500	500
15	NOx (any source)	2,500	1,000
16	NOx (acid manufacturing)	4,000	1,000
17	H_2SO_4 (any source)	300	35
18	HNO_3	2,000	70
19	Ammonia	300	100

Note: Standard analysis methods of concentrations of the parameters in the industrial emission gases are specified in current TCVNs.

Air Quality: Industrial Emission Standards Organic Substances

TCVN 5940-1995

1. Scope

1.1 This standard specifies the maximum concentrations of organic substances in industrial emission gases (in mg/m^3 of emission gas) emitted into ambient air.
In this standard, **Industrial emission gas** means: smoke, gas of organic substances or smokes, gases containing organic substances produced by sources of any industrial process, or by sources of any servicing or trading activity, or by other activities.

1.2 This standard is applied to control of concentration of organic substances in the industrial emission gases before being discharged into atmosphere.

2. Limitation Values

2.1 Chemical nomenclature and formula of organic substances in industrial emission gases and maximum allowable concentrations of those emitted into the atmosphere are specified in Table 17.1.28.

2.2 The limit values of the concentration of industrial emission gases produced by particular sources (e.g. oil refinery, etc.) are specified in separate standards.
Note: Standard analysis method of concentrations of the parameters in the industrial emission gases are specified in current TCVNs.

Table 17.1.28 Maximum Allowable Concentration (MAC) of the Organic Substances Emitted into Atmosphere

No.	3) Nomenclature	Chemical Formula	MAC
1	Acetone	CH_3COCH_3	2,400
2	Acetylene tetrabromide	$CHBr_2CHBr_2$	14
3	Acetaldehyde	CH_3CHO	270
4	Acrolein	$CH_2=CHCHO$	1,2
5	Amyl acetate	$CH_3COOOC_5H_{11}$	525
6	Aniline	$C_6H_5NH_2$	19
7	Acetic anhydride	$(CH_3CO)_2O$	360
8	Benzidine	$NH_2C_6H_4C_6H_4NH_2$	None
9	Benzene	C_6H_6	80
10	Chlorobenzyl	$C_6H_5CH_2Cl$	5
11	Butadiene	C_4H_6	2,200
12	Butane	C_4H_{10}	2,350
13	Butylaxetate	$CH_3COOC_4H_9$	950
14	n-Butanol	C_4H_9OH	300
15	Butylamine	$CH_3(CH_2)_2CH_2NH_2$	15
16	Cresol (o-, m-, p-)	$CH_3C_6H_4OH$	22
17	Chlorobenzene	C_6H_5Cl	350
18	Chloroform	$CHCl_3$	240
19	ß-Chloroprene	$CH_2=CClCH=CH_2$	90
20	Chloropicrin	CCl_3NO_2	0.7
21	Cyclohexane	C_6H_{12}	1,300
22	Cyclohexanole	$C_6H_{11}OH$	410
23	Cyclohexanone	$C_6H_{10}O$	400
24	Cyclohexene	C_6H_{10}	1,350
25	Diethylamine	$(C_2H_5)_2NH$	75
26	Difluorodibromomethane	CF_2Br_2	860
27	o-Dichlorobenzene	$C_6H_4Cl_2$	300
28	1,1-Dichloroethane	$CHCl_2CH_3$	400
29	1,2-Dichloroethylene	$ClCH=CHCl$	790
30	1,2-Dichlorodifluromethane	CCl_2F_2	4,950
31	Dioxane	$C_4H_8O_2$	360
32	Dimethylaniline	$C_6H_5N(CH_3)_2$	25
33	Dichloroethyl ether	$(ClCH_2CH_2)_2O$	90

34	Dimethylformamide	$(CH_3)_2NOCH$	60
35	Dimethyl sulfate	$(CH_3)_2SO_4$	0.5
36	Dimethylhydrazine	$(NH_3)_2NNH_2$	1
37	Dinitrobenzene (o-, m-, p-)	$C_6H_4(NO_2)_2$	1
38	Ethyl acetate	$CH_3COOC_2H_5$	1,400
39	Ethyl amine	$CH_3CH_2NH_2$	45
40	Ethyl benzene	$CH_3CH_2C_6H_5$	870
41	Ethyl bromide	C_2H_5Br	890
42	Ethylene diamine	$NH_2CH_2CH_2NH_2$	30
43	Ethylene dibromide	CHBr=CHBr	190
44	Ethanol	C_2H_5OH	1,900
45	Ethyl acrylate	$CH_2=CHCOOC_2H_5$	100
46	Ethylene chlorohydrin	CH_2ClCH_2OH	16
47	Ethylene oxide	CH_2OCH_2	20
48	Ethyl ether	$C_2H_5OC_2H_5$	1,200
49	Ethyl chloride	CH_3CH_2Cl	2,600
50	Ethyl silicate	$(C_2H_5)_4SiO_4$	850
51	Ethanol amine	$NH_2CH_2CH_2OH$	45
52	Furfural	C_4H_3OCHO	20
53	Formaldehyde	HCHO	6
54	Furfuryl	$C_4H_3OCH_2OH$	120
55	Fluorotrichloromethane	CCl_3F	5,600
56	n-Heptane	C_7H_{16}	2,000
57	n-Hexane	C_6H_{14}	450
58	Isopropylamine	$(CH_3)_2CHNH_2$	12
59	Isobutanol	$(CH_3)_2CHCH_2OH$	360
60	Methyl acetate	CH_3COOCH_3	610
61	Methyl acrylate	$CH_2=CHCOOCH_3$	35
62	Methanol	CH_3OH	260
63	Methyl acetylene	$CH_3C=CH$	1,650
64	Methyl bromide	CH_3Br	80
65	Methyl cychlohexane	$CH_3C_6H_{11}$	2,000
66	Methyl cychlohexanol	$CH_3C_6H_{10}OH$	470
67	Methyl cychlohexanone	$CH_3C_6H_9O$	460
68	Methyl chloride	CH_3Cl	210
69	Methylene chloride	CH_2Cl_2	1,750
70	Methyl chloroform	CH_3CCl_3	2,700
71	Monomethylaniline	$C_6H_5NHCH_3$	9
72	Methanol amine	$HOCH_2NH_2$	31
73	Naphthalene	$C_{10}H_8$	150
74	Nitrobenzene	$C_6H_5NO_2$	5
75	Nitroethane	$CH_3CH_2NO_2$	310
76	Nitroglycerin	$C_3H_5(NO_2)_3$	5
77	Nitromethane	CH_3NO_2	250
78	2-Nitropropane	$CH_3CH(NO_2)CH_3$	1,800
79	Nitrotoluene	$NO_2C_6H_4CH_3$	30
80	Octane	C_8H_{18}	2,850
81	Pentane	C_5H_{12}	2,950
82	Pentanone	$CH_3CO(CH_2)_2CH_3$	700
83	Phenol	C_6H_5OH	19
84	Phenyl hydrazine	$C_6H_5NHNH_2$	22
85	Tetrachloroethylene	$CCl_2=CCl_2$	670
86	Propanol	$CH_3CH_2CH_2OH$	980
87	Propyl acetate	CH_3-COO-C_3H_7	840
88	Propylene dichloride	CH_3-CHCl-CH_2Cl	350

89	Propylene oxide	C_3H_6O	240
90	Propylene ether	$C_3H_5OC_3H_5$	2,100
91	Pyrindine	C_5H_5N	30
92	Pyrene	$C_{16}H_{10}$	15
93	Quinone	$C_6H_4O_2$	0.4
94	Styrene	$C_6H_5CH=CH_2$	420
95	Tetrahydrofural	C_4H_8O	590
96	1,1,2,2-Tetrachloroethane	$Cl_2HCCHCl_2$	35
97	Tetrachloromethane	CCl_4	65
98	Toluene	$C_6H_5CH_3$	750
99	Tetranitromethane	$C(NO_2)_4$	8
100	Toluidine	$CH_3C_6H_4NH_2$	22
101	Toluene-2,4-diisocyanate	$CH_3C_6H_3(NCO)_2$	0.7
102	Triethylamine	$(C_2H_5)_3N$	100
103	1,1,2-Trichloroethane	$CHCl_2CH_2Cl$	1080
104	Trichloroethylene	$ClCH=CCl_2$	110
105	Trifluorobromethane	$CBrF_3$	6,100
106	Xylene (o-,m-,p-)	$C_6H_4(CH_3)_2$	870
107	Xylidine	$(CH_3)_2C_6H_3NH_2$	50
108	Vinyl chloride	$CH_2=CHCl$	150
109	Vinyltoluene	$CH_2=CHC_6H_4CH_3$	480

Table 17.1.29 Noise in Public and Residential Areas Maximum Permitted Noise Level (TCVN 5949-1995)

(Unit: dB)

No.	Area	Period of Time		
		From 6^h AM to 18^h	From 18^h to22^h	From 22^h to 6^h AM
1	Quiet areas: • Hospitals • Libraries • Sanatoria • Kindergartens, schools	50	45	40
2	Residential area: • Hotels, administration offices • Houses, apartment houses, etc.	60	55	45
3	Commercial and service areas and mix	70	70	50
4	Small industrial factories intermingling in residential areas	75	70	50

Table 17.1.30 Road Motor Vehicle Noise Maximum Permitted Noise Level (TCVN 5948-1995)

No.	Category of Vehicles	Maximum Noise Level Permitted (dBA)
1	Motorcycles, cylinder capacity (CC) of the engine does not exceed 125 cm^3	80
2	Motorcycles, CC of the engine exceeds 125 cm^3	85
3	Motorized tricycles	85
4	Cars, taxi, passenger vehicle for the carriage of not more than 12 passengers	80
5	Passenger vehicle constructed for the carriage of more than 12 passengers	85
6	Truck, permitted maximum weight does not exceed 3,5	85

	tones	
7	Truck, permitted maximum weight exceed 3,5 tones	87
8	Truck, engine is more than 150 kW	88
9	Tractor, or any other truck not elsewhere classified or described in this column of the table	90

Air Quality: Maximum Allowable Limits of Pesticide Residues in the Soil TCVN 5941-1995

1. Scope

1.1 This standard specifies maximum allowable concentrations of pesticides in soil.
In this standard, **Pesticide** means: herbicide, fungicide, insecticide as specified by Ministry of the Agriculture and Foods industry in List of pesticides permitted to use in Vietnam.

1.2 This standard is applied to control and to evaluation of pesticide contaminant level in soil.

2. Limitation Values

Names and maximum allowable concentrations of pesticides in soil are shown in Table 17.1.31.

Table 17.1.31 Pesticide Residue in Soil: Maximum Allowable Concentrations (MAC)

No.	Common and Trade Names	Chemical Formula	Use	MAC (mg/kg)
1	Atrazine	$C_8H_{14}ClN_5$	Herbicide	0.2
2	2,4 - D	$C_8H_6Cl_2O_3$	Herbicide	0.2
3	Dalapon	$C_3H_4Cl_2O_2$	Herbicide	0.2
4	MPCA	$C_9H_9ClO_3$	Herbicide	0.2
5	Sofit	$C_{17}H_{26}ClNO_2$	Herbicide	0.5
6	Fenoxaprop-ethyl (Whip S)	$C_{16}H_{12}ClNO_5$	Herbicide	0.5
7	Simazine	$C_7H_{12}ClN_5$	Herbicide	0.2
8	Cypermethrin	$C_{22}H_{19}Cl_2NO_3$	Herbicide	0.5
9	Saturn (Benthiocarb)	$C_{12}H_{16}ClNOS$	Herbicide	0.5
10	Dual (Metolachlor)	$C_{15}H_{22}ClNO_2$	Herbicide	0.5
11	Fuji - One	$C_{12}H_{18}O_4S_2$	Fungicide	0.1
12	Fenvalerate	$C_{25}H_{22}ClNO_3$	Insecticide	0.1
13	Lindane	$C_6H_6Cl_6$	Insecticide	0.1
14	Monitor (Methamidophos)	$C_2H_8NO_2PS$	Insecticide	0.1
15	Monocrotophos	$C_7H_{14}NO_5P$	Insecticide	0.1
16	Dimethoate	$C_5H_{12}NO_3PS_2$	Insecticide	0.1
17	Methyl Parathion	$C_8H_{10}NO_5PS$	Insecticide	0.1
18	Triclofon (Clorophos)	$C_4H_8Cl_3O_4P$	Insecticide	0.1
19	Padan	$C_7H_{16}N_3O_2S_2$	Insecticide	0.1
20	Diazinone	$C_{12}H_{21}N_2O_3PS$	Insecticide	0.1
21	Fenobucarb (Bassa)	$C_{12}H_{17}NO_2$	Insecticide	0.1
22	DDT		Insecticide	0.1

Note: Sampling of arable soil for determination of pesticide contaminant level should be taken just after the harvest.

17.2 Initial Environmental Examination

(1) Objective of the Initial Environmental Examination Study

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

The major objective of IEE is to establish present environmental and social conditions of the project

area through available data/information to predict the impacts on relevant environmental and social attributes due to the construction and operation of the proposed water supply system, to suggest appropriate and adequate mitigation measures to minimise/reduce adverse impacts.

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

Table 17.2.1 Requirement of Environmental and Social Considerations in Vietnam for the Water Supply Project

Prescribed Project with Requirement of Environmental Considerations	Outline of Selected Water Supply Projects for the Feasibility Study
< Condition of SEA requirement > • National socio-economic development strategies and plans; • Strategies, planning and plans for development of branches or domains on a national scale; • Socio-economic development strategies, planning and plans of provinces, centrally run cities or regions; • Planning for land use, forest protection and development; exploitation and utilization of other natural resources in inter-provincial or inter-regional areas; • Planning for development of key economic regions; • General planning of inter-provincial river watersheds.	The study areas are located in 15 candidate communes of four (4) provinces. These projects are rural water supply and these project areas are not planned across the provincial area. Therefore, SEA is not required.
< Condition of EIA requirement > • Projects of national importance; • Projects planned to use part of land of or exerting adverse impacts on, the natural sanctuaries, national parks, historical and cultural relic sites, natural heritages or beautiful landscapes; • Projects to potentially exert adverse impacts on the river watershed, coastal areas or areas of protected ecosystems; • Projects to construct new urban centers or concentrated residential areas; • Projects to exploit and use groundwater or natural resources on a large scale; • Projects to exploit groundwater with a capacity of 10,000m^3/day or more.	These project areas do not include natural preserve and historical /cultural areas, and the environment impacts are minor due to small size facility of rural water supply. Water source of four (4) water supply projects among nine (9) systems is groundwater. The planned groundwater exploitation (daily average) ranges from 485 m^3/day to 998 m^3/day in 2020. Therefore, EIA is not required.
< Condition of EPC requirement > • Projects except for the aforementioned projects.	EPC is required for selected projects for the Feasibility Study.

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

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

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

projects for the Feasibility Study.

(2) Overall Impact Identification

Based on field survey and data collection, adverse impacts by implementation of projects and degree of impact were considered. The overall Impact Identification is presented in Table 17.2.2.

Table 17.2.2 Scope Matrix for Project Components

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

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

(3) Impact Identification and Mitigation Measures

In this section, background, adverse impacts, and mitigation or reduction countermeasures for the environmental and social items mentioned above are described.

1) Involuntary Resettlement

In water supply projects, land acquisition for water supply facilities is necessary, and these water supply facilities are well, water intake, water treatment plant, distribution reservoir and pump station. The location of the water supply facilities was decided based on the water supply plan. The required land area for water supply facilities ranges from 50 m^2 to 2,025 m^2, and 80% of all sites are 225 m^2 (15m x15m) or smaller in size. As a policy of site selection, it is selected in order of the land use situation of site as listed below, and land with building is excluded from the list of candidate for selection.

- Public land
- Private use land (vacant land /fallow land)
- Private use land (agricultural land (such as pasture, upland field))
- Private use land (agricultural land (such as paddy field))

From results of the site selection, the proposed project sites are located in public or private use land without buildings. (refer to Table 17.2.3) Therefore, no resettlement is expected by land acquisition.

Table 17.2.3 Project Site of Water Supply Facilities

System No.	Commune Code	Commune	Facility	Land owner	Required area(m2)		Land use conditions	Existence of buildings	Category of farm land	Crop
FPS-2	P-2	An Dinh	Intake (pipe)	Public	100	(10m x 10m)	inside of reservoir	No		
			Water treatment plant	Public	1,000	(25m x 40m)	no use	No		
			Distribution reservoir	Private	225	(15m x 15m)	agriculture	No	upland field	cassava
FPS-3	P-4	An My	Intake (JICA Well)	Private	25	(5m x 5m)	no use	No		
			Distribution reservoir	Private	225	(15m x 15m)	no use	No		
FPG-4	P-5	Son Phuoc	Intake	Public	200	(20m x 10m)	no use	No		
	P-6	Ea Cha Rang	Water treatment plant	Private	1,650	(30m x 55m)	no use	No		
	P-7	Suoi Bac	Distribution reservoir	Private	100	(10m x 10m)	no use	No		
FPS-5	P-8	Son Thanh Dong	Intake (JICA Well)	Private	25	(5m x 5m)	agriculture	No	upland field	cassava
			Distribution reservoir	Public	225	(15m x 15m)	open area of CPC	No		
FKS-6	K-1	Cam An Bac	Intake (JICA Well)	Private	25	(5m x 5m)	no use	No		
			Water treatment plant	Private	1,125	(45m x 25m)	no use	No		
			Distribution Reservoir	Private	100	(10m x 10m)	no use	No		
FKS-8	K-3	Cam Hai Tay	Intake (Reservoir)	Public	100	(10m x 10m)	no use	No		
			Intake (Well field)	Private	25	(5m x 5m)	no use	No		
			Water treatment plant	Private	800	(40m x 20m)	agriculture	No	upland field	cassava
			Distribution reservoir	Private	100	(10m x 10m)	agriculture	No	upland field	cassava
FNG-10	N-5	Phuoc Hai	Intake (River)	Public	200	(20m x 10m)	no use	No		
	N-6	Phuoc Dinh	Water treatment plant	Private	4,225	(65m x 65m)	agriculture	No	upland field	sugarcane
			Distribution reservoir	Private	400	(20m x 20m)	no use	No		
FBS-11	B-1	Muong Man	Intake (Reservoir)	Private	150	(10m x 15m)	no use	No		
			Water treatment plant	Private	1,500	(30m x 50m)	no use	No		
FBG-13	B-3	Nghi Duc	Intake (River)	Public	200	(10m x 20m)	no use	No		
	B-5	Me Pu	Water treatment plant	Private	6,750	(90m x 75m)	agriculture	No	paddy field	paddy field
	B-6	Sung Nhon	Distribution reservoir 1	Private	400	(20m x 20m)	no use	No		
	B-7	Da Kai	Distribution reservoir 2	Public	150	(10m x 15m)	no use	No		
			Pump Station	Private	25	(5m x 5m)	no use	No		

2) Local Economy

By implementation of water supply projects, residents can get safe water easily also in the dry season. However, the adverse impact on commercial activities of water vender may be expected by construction of water supply system.

Considering this issue, the situation of water venders in the target commune for F/S was investigated through interviews of the commune leaders, and the results of survey are presented in Table 17.2.4.

Table 17.2.4 Situation of Water Vender in the Target Commune for F/S

Province	System Code	Commune Code	Number of water venders			Commercial Period
			Total	Permanent work	Additional work	
Phu Yen	FPS-2	P-2	0	0	0	
	FPS-3	P-4	0	0	0	
	FPG-4	P-5	2-3	0	2-3	Dry season
		P-6	0	0	0	
		P-7	5-6	0	5-6	Dry season
	FPS-5	P-8	0	0	0	
Khanh Hoa	FKS-6	K-1	2-3	0	2-3	Dry season
	FKS-8	K-3	15	0	15	Dry season
Ninh Thuan	FNG-10	N-5	0	0	0	
		N-6	0	0	0	
Binh Thuan	FBS-11	B-1	0	0	0	
	FBG-13	B-3	0	0	0	
		B-5	0	0	0	
		B-6	0	0	0	
		B-7	2-3	0	2-3	Dry season

From results of the investigation, the salient features of the water venders in the target communes are listed below.

- The activity of water vender exists in five communes.
- Water vending are the side job of the farmer in the target communes.
- Activity of the water vending is only practiced during the dry season.
- Number of the water venders in the target communes is less than five or six, except K-1 commune, which has 15 water venders. All of the water venders are residents in the target communes.
- The cow carriages and vehicles, which are mainly used for agricultural works on a daily basis, are applied for water conveyance.
- Large investment has not been made for water venders' activity.

From the existing situation of water venders, it can be said that adverse impacts on commercial activities of water vender is expected by implementation of water supply projects.

Therefore, in consideration of the water vender in the target communes, proposed countermeasures for mitigation or reduction of adverse impacts are described below.

i) Promotion of employment

Promotion of employment of water venders by the public corporation for O/M of water supply system

is recommended. However, since their main job is farming, their employment status should be seasonal or part-time.

ii) Promotion of agricultural activity

It is also recommended that water venders return back to their original practices of farming.
In recent years, the farmers in this area have increased their income by retail sales of agricultural products. Considering this point, instruction of agricultural technology for cash crops is recommended. Since fundamental conditions of retail sales system have been already founded, an increase in farmer's income can be expected and it shall contribute to regional economic development.

3) Land use and utilization of local resources

As already described in the section of "a) Involuntary Resettlement", the proposed project sites are located in public or privately owned land, and land use of private lands are basically vacant land or agricultural. (refer to Table 17.2.3) From this Table, the land use situations of the proposed project sites are listed below.

- Total number of project sites is 27.
- Of these 27 sites, eight (8) sites are located in public land.
- 19 remaining sites include private land where Land Use Right is approved.
- Among 19 private lands, six sites are located in agricultural land.
- Among six sites of agricultural land, five sites are upland field for cassava and sugarcane, and one site includes paddy field.

In site selection, care was taken to avoid those sites that include agricultural land and prefer other alternatives. However, it was not possible to exclude sites including five agricultural lands (upland field) for cassavas or sugarcane and one paddy field as described above. This is water supply project and therefore has numerous beneficial effects in terms of providing safe and sufficient potable water and will have positive impact on health and living conditions of people. However, expropriation of agricultural land is needed as a part of the project site.
In Vietnam, compensation of land expropriation in public project such as water supply project is clearly prescribed by the Law on Land (No.13/2003/QH11) and Decree N0. 197/2004/ND-CP.
The most relevant article related to the compensation of project site is Article 6 “Compensation principles” of Decree N0. 197/2004/ND-CP and is described below.

<u>Article 6 Compensation principles</u>

- Persons whose land is acquired shall be compensated with new land that could be used for same purposes.
- If there is no such land available for compensation, they shall receive compensation equal to the land use right value at the time of issuance of the acquisition decisions
- In case of compensation with new land or houses, if there is any difference in value, such difference shall be paid in cash.

In water supply projects, it is expected that proper and sufficient compensation including the grant of an alternative agricultural land is carried out based on the Vietnamese Law and Regulation, and it can be judged that an adverse impact on the land users shall be mitigated or eliminated.

Preliminary Cost Estimation of Compensation for Private-use Land

In this section, a rough estimation of compensation cost for private land is made based on the collected information and assumptions.

As mentioned above, total number of proposed project sites are 27, and of these 27 project sites, 19 sites include private land. Basically, the compensation expense of land is required for recovery of private land. However, according to the land law and regulations in Vietnam, persons whose land is recovered shall be compensated with new land that could be used for same purposes. If such land is not available for compensation, they shall receive compensation equal to the land use right value at the time of issuance of the land acquisition decisions. In this section, compensation expense is calculated considering the assumption that compensation shall be made in terms of money.

The conditions used for this calculation are listed below.

- The compensation cost for land is calculated considering land compensation unit price and land area.
- In principle, the land compensation unit price was obtained through interview with commune leaders. This investigation was conducted in June 2008.
- Compensation for cultivated plants has also been considered. However, annual agricultural product that would be cultivated after land expropriation is not included in compensation expense.
- The estimated compensation costs are considered as the present price in 2008.

Estimation result of compensation for the private land is presented in Table 17.2.5.

Table 17.2.5 Preliminary Cost Estimation of Compensation for Private-use Land

System No.	Commune Code	Commune	Facility	Land owner	Required area(m2)	Compensation cost				
						Unit land price (VND/m^2)	Compensation cost for land (x1000 VND)	Unit price for Trees * (VND/m^2)	Compensation cost for trees (x1000 VND)	Total (x1000 VND)
FPS-2	P-2	An Dinh	Intake (pipe)	Public	100					
			Water treatment plant	Public	1,000					
			Distribution reservoir	Private	225	14,000	3,150			3,150
FPS-3	P-4	An My	Intake (JICA Well)	Private	25	30,000	750			750
			Distribution reservoir	Private	225	14,000	3,150			3,150
FPG-4	P-5	Son Phuoc	Intake	Public	200					
	P-6	Ea Cha Rang	Water treatment plant	Private	1,650	14,000	23,100	2,600	4,290	27,390
	P-7	Suoi Bac	Distribution reservoir	Private	100	14,000	1,400			1,400
FPS-5	P-8	Son Thanh Dong	Intake (JICA Well)	Private	25	14,000	350			350
			Distribution reservoir	Public	225					
FKS-6	K-1	Cam An Bac	Intake (JICA Well)	Private	25	8,000	200			200
			Water treatment plant	Private	1,125	8,000	9,000			9,000
			Distribution Reservoir	Private	100	8,000	800			800
FKS-8	K-3	Cam Hai Tay	Intake (Reservoir)	Public	100					
			Intake (Well field)	Private	25	9,000	225			225
			Water treatment plant	Private	800	9,000	7,200			7,200
			Distribution reservoir	Private	100	9,000	900			900
FNG-10	N-5	Phuoc Hai	Intake (River)	Public	200					
	N-6	Phuoc Dinh	Water treatment plant	Private	4,225	18,000	76,050			76,050
			Distribution reservoir	Private	400	18,000	7,200			7,200
FBS-11	B-1	Muong Man	Intake (Reservoir)	Private	150	15,000	2,250			2,250
			Water treatment plant	Private	1,500	15,000	22,500			22,500
FBG-13	B-3	Nghi Duc	Intake (River)	Public	200					
	B-5	Me Pu	Water treatment plant	Private	6,750	12,000	81,000			81,000
	B-6	Sung Nhon	Distribution reservoir 1	Private	400	12,000	4,800			4,800
	B-7	Da Kai	Distribution reservoir 2	Public	150					
			Pump Station	Private	25	15,000	375			375
Total				-	20,050	-	244,400	-		248,690

4) Existing social infrastructures and services (such as traffic / public facilities)

Disruptions of vehicular and pedestrian traffic might occur during the construction stage of water supply system. In particular, conveyance and main distribution lines are laid along road or road maintenance area, and disruptions of traffic will be expected. Two items of traffic situations, which should be given due care, are described below.

- Since most of the conveyance and distribution lines shall be aligned along community roads, not much passing of vehicles is expected. However, even on community roads the traffic of motorbikes is concentrated during peak hours mainly in morning and evening. Therefore, occupancy of roads by distribution line construction activities shall affect normal traffic situation. The occurrence of traffic accident is also expected during peak traffic hours particularly in morning and evening.
- In the target commune of Cam Hai Tay (K-3), the national road divides the water service area proposed in this project, and a distribution line crosses the national road. Traffic congestion might occur on the national roads in the stage of distribution pipe lying.

These impacts could be mitigated or minimized by the following countermeasures:

- The announcement and public notification concerning the construction of facilities and its schedule ahead of the start of construction.
- During the construction period, watchman or traffic control staffs will be deployed at the site to control the traffic.
- With careful attention to the fluctuation in traffic load, if necessary, increase of traffic control staff and arrangement of the staff should be considered.
- Temporary fences with appropriate warning signs should be used to isolate the construction site. Especially, construction sites in the vicinity of schools, and locations of public concentration should be strictly fenced.
- If blockages to roads and other services are unavoidable, such blockage areas should be identified well in advance and circulation should be distributed to public with appropriate details on maps.
- At present, a bridge construction work is undergoing on a national road in the study area. This construction is implemented applying single-sided lane regulation and one-way traffic regulation for large cars. As mitigation measures, the same method (performed by the bridge construction) is suitable for construction of the distribution line in the vicinity of national road of Cam Hai Tay (K-3).

During the construction stage, the project owner or building constructor should arrange an information desk and a person responsible at the construction site office.

5) Water usage or water rights and rights of common

Nine water supply systems are selected for the feasibility study, of which six systems utilize surface water as their raw water sources. (refer to **Table 5.6**) Especially, three systems receive surface water from irrigation reservoir.

In consideration of this situation, utilization of the surface water in six water supply systems was deliberated by DARD and DONRE which are agricultural water and river administrator.

From deliberation results, it is judged that water supply projects can obtain the raw water from rivers and reservoirs in dry season, and in addition, the existing water rights are not affected.

6) Groundwater

The influence on groundwater was considered in the Master Plan. The communes for which groundwater quality was observed to be not suitable as drinking water or in cases when volume of groundwater was not enough were excluded from the group of target communes for the feasibility study. From the results of the test borehole drilling survey, P-4, P-8 and K-1 communes were selected as the target systems in the feasibility study in consideration of groundwater quality and productivity of groundwater.

The characteristics of target aquifer of the boreholes in the water supply systems are quite different from the dug wells which most of villagers are using as source of water in present situation. Therefore, adverse impacts such as drawdown, seawater intrusion and so on seem to be negligible.

However, from a viewpoint of groundwater preservation, monitoring of groundwater quality and groundwater level is recommended. (See Table 17.2.9)

7) Flora, fauna and biodiversity

There are 19 nature conservation areas including six main conservation areas in four provinces of the Study area. Eight water supply system areas, except P-6 commune (system code: FPG-4), are at far distance from existing 19 nature conservation areas. Ea Cha Rang commune (P-6), as target commune for F/S, is located adjoining the nature conservation area (Krong Trai Special-use Forest). (refer to Table 17.2.6 and Table 17.2.7)

Table 17.2.6 Six Main Conservation Areas in the Study Area

No.	Nature Conservation Area	Area (ha)	Province	District
1	Krong Trai Special-use Forest	13,392	Phe Yen	Son Hoa
2	Deo Ca-Hon Nua Restricted Forest	5,768	Phu Yen	Tuy Hoa
3	Phuoc Binh National Park	19,814	Ninh Thuan	Bac Ai
4	Nui Chua National Park	22,513	Ninh Thuan	Ninh Hai
5	Ta Kou Special-use Forest	17,823	Binh Thuan	Ham Thuan Nam
6	Nui Ong Special-use Forest	25,468	Binh Thuan	Thanh Linh

Table 17.2.7 Other Conservation Areas in the Study Area

No.	Nature Conservation Area	Area (ha)	Province	Categories
7	Cu Mong lagoon	3,000	Phu Yen	Category – A & B
8	Song Hinh lake	4,100	Phu Yen	Category – A
9	Ba River estuary	1,000	Phe Yen	Category – A
10	O Loan wetland	1,570	Phu Yen	Category – A & B
11	Ro lagoon	-	Phu Yen	Category – A
12	Trao lagoon	5,000	Phu Yen	Category – A
13	Nha Phu – Hon Heo	-	Khanh Hoa	Category – B

14	Hon Mun	-	Khanh Hoa	Category – B
15	Thuy Trieu	-	Khanh Hoa	Category – B
16	Nai wetland	700	Ninh Thuan	Category – A & B
17	Ho Bien Lac	2,000	Binh Thuan	Category – A
18	Hon Cau-Vinh Hao	-	Binh Thuan	Category – B
19	Kalon Song Mao	-	Binh Thuan	-

Category-A: The important wetlands (MOSTE/NEA, 2000)
Category-B: This category is proposed marine protected areas by ADB (1999)

The water supply system (FPG-4) consists of three communes including Son Phuoc (P-5), Ea Cha Rang commune (P-6) and Suoi Bac (P-7). This planning area is located near the Krong Trai Special-use Forest, but, the Special-use Forest is not including the planning area. Furthermore, it was admitted by DARD and DONR in Phu Yen province that the water supply project does not influence Krong Trai Special-use Forest.

Therefore, it is expected that there is no adverse impacts on nature preserve area (Krong Trai Special-use Forest) by the water supply project. However, since Krong Trai Special-use Forest includes the partial administrative area of P-6 Ea Cha Rang commune, the outline of flora, fauna and biodiversity of Krong Trai Special-use Forest has been described below.

i) Topography and hydrology of the Krong Trai Special-use Forest

Krong Trai Nature Reserve is situated in the transition zone between the Central Highlands and the coastal zone of south-central Vietnam. The topography of the nature reserve consists of two types. The east and northeast of the nature reserve is characterized by low hills, including Ca Te (560 m), Hon Dat (590 m), Hon O (574 m) and others. The other area of the nature reserve is characterized by flat areas with some scattered low hills about 150 m in elevation.

Streams in the eastern part of the nature reserve feed the Cha Rang River. Streams in the western part feed the Lam and Ba rivers. Most streams within the nature reserve are dry during the dry season, except in a small swampy area in the southwest of the nature reserve.

ii) Flora, Fauna and Biodiversity of the Krong Trai Special-use Forest

Krong Trai Nature Reserve supports three main forest types: evergreen forest (1,003 ha), semi-deciduous forest (7,111 ha) and deciduous forest (7,891 ha). Other habitats present include grassland, scrub and swamp.

A field survey in 1990 recorded 236 vascular plant species. The families with the greatest number of species are the Euphorbiaceae, Caesalpiniaceae, Poaceae, Fabaceae and Moraceae. The nature reserve supports at least nine plant species listed in the Red Data Book of Vietnam, including Aquilaria crassna, Dalbergia bariensis, D. cochinchinensis, and D. annamensis; and a number of species with high economic value, such as rattan, palms and medicinal plants.

A total of 262 vertebrate species have been recorded at the nature reserve, comprising 50 mammal, 182 bird, 22 reptile and eight amphibian species. Species of particular conservation importance that have been recorded at Krong Trai include Banteng Bos javanicus, Gaur Bos gaurus, Green Peafowl

Pavo muticus and Crested Argus Rheinardia ocellata.

However, the current status of these species is unclear; Duckworth and Hedges (1998) reviewed the evidence of the continued occurrence of Gaur and Banteng at Krong Trai and concluded that it was 'provisional'. In the past, Krong Trai was renowned as a site for Siamese Crocodile Crocodylus siamensis (Vu Van Dung pers. comm.) but there is no evidence of the continued occurrence of this species at the site. (Source: Sourcebook of Existing and Proposed Protected Areas in Vietnam, 2001)

8) Water pollution

By the implementation of water supply project, residents can receive sufficient water supply services in the dry season, and as a result it is expected that the volume of generated domestic wastewater in the dry season shall increase. If generated wastewater is discharged untreated into existing public water bodies, it may pollute these water bodies during dry season. Possibility of Water pollution in public water bodies of the target commune for F/S is discussed below.

For the items described below, the information is collected from the commune leader and through field survey of the central area of commune carried out in dry season. (It is assumed that the rainy season does not generate water pollution due to the dilution effect of rainwater compared to the dry season. Therefore, the survey is undertaken in the dry season when water quality tends to deteriorate by reduction of river flow.)

(A) Situation of domestic wastewater disposal at household

(B) Situation of drainage canal /ditch in dry season

(C) Situation of water pollution in public water bodies

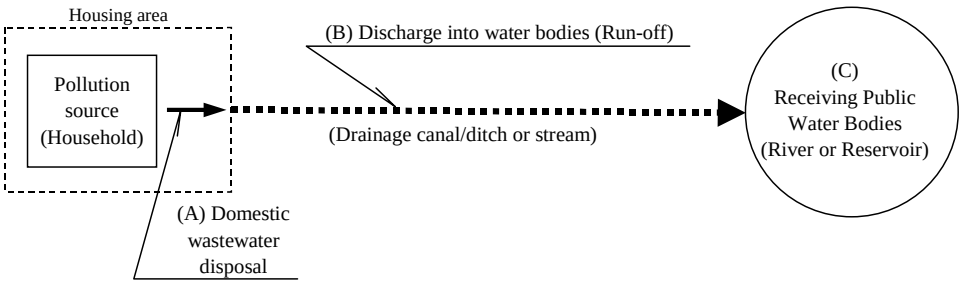


Figure 17.2.1 Water Pollution Mechanisms by Domestic Wastewater

Based on the results of the above survey, the salient features of wastewater disposal in the target communes have been identified. The features are listed below.

- Usually, villagers use water in the open air and wastewater is sprinkled over the yard.
- The entire study area has a soil characteristic with high permeability, and wastewater infiltrates easily into the ground.
- Rainwater drainage canals /ditches in the dry season are dried, and wastewater is not seen in most of the drainage canals. (No wastewater is discharged into public water bodies)

- There are no polluted water bodies by the domestic wastewater in the target communes throughout a year.

According to the water supply plan, unit water consumption in existing (2007) and future (2020) condition is same that is 60 lcd. Therefore, the amount of increase in domestic wastewater shall correspond to the increase in population. Growth rate of population served is shown in Table 17.2.8.

Considering that the water pollution of public water bodies is proportional to the amount of wastewater, it will be presumed that the water quality parameter values in 2020 increases about 1.5 times in N-6 commune, and 23% on average, if no wastewater treatment measures are adopted.

Table 17.2.8 Growth Rate of Population Served

Province	System Code	Commune Code	Population served (persons)		b/a
			(a) 2006	(b) 2020	
Phu Yen	FPS-2	P-2	5,964	6,856	115%
	FPS-3	P-4	11,427	13,256	116%
	FPG-4	P-5	2,484	3,101	125%
		P-6	2,206	2,624	119%
		P-7	5,626	6,411	114%
	FPS-5	P-8	8,240	9,292	113%
Khanh Hoa	FKS-6	K-1	5,011	6,462	129%
	FKS-8	K-3	10,620	12,840	121%
Ninh Thuan	FNG-10	N-5	12,881	16,804	130%
		N-6	8,549	12,911	151%
Binh Thuan	FBS-11	B-1	5,977	7,378	123%
	FBS-13	B-3	10,192	11,869	116%
		B-5	13,250	16,315	123%
		B-6	8,175	9,794	120%
		B-7	11,436	14,263	125%
Total			122,038	150,176	123%

From the existing disposal condition of domestic wastewater, additional impact caused by this project is negligible. Similarly, although the increase in the amount of domestic wastewater by increase in population can be considered, it is estimated that serious water pollution shall not be caused. However, installation of the simple treatment facilities (such as leaching pit) of domestic wastewater is recommended also from viewpoint of improvement of living environment in the future.

i) Noise and vibration

During construction works in the project, some noise and vibration will be generated by heavy equipments for construction. At present, there is no hospital, school, and private house in around the proposed construction sites. Therefore, the influence of noise and vibration during construction work of the water supply facilities is minor or negligible.

If necessary, the following mitigation or reduction measures against the noise and vibration by the construction works can be proposed.

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

9) Land subsidence

The impact of groundwater withdrawal on land subsidence was checked in the Master Plan. Appropriate withdrawal volume is designed for the water supply facility based on the pumping test results in the test boreholes drilling survey, and the target aquifer is fissure or weathered basement rocks. Therefore, there is no possibility of land subsidence.

10) Accidents

During construction and operation stage of the water supply project, some accidents are expected.

i) Construction stage (war residual substances)

War residual substances (dud bomb, mine, etc.) need to be eliminated before construction starts. The clearance of war residual substances should be carried out immediately after land acquisition in this project.

ii) O/M stage (water pollution and contamination by accident)

For cases in which river water source is proposed to be utilized, neither serious water contamination nor water quality accident is reported at water intake points which are proposed in this project. However, raw surface water source of water supply may experience contamination by accident. For example, abandonment of the cyanide in illegal golden mining has been reported.

Especially, the contamination by substance which has influence on water use and human health should be considered. If such a situation occurs, measures have to be taken such that raw water bypass and operation stop immediately.

These impacts can be mitigated by adopting the following countermeasures:

- Implementation of regular water quality monitoring
- Installation of the monitoring instrument (aquarium) using a living nature such as fish is also effective.
- Establishment of urgent communication network with the river administrator and related organization. (If possible, the fishermen and farmer who work near the river will be included.)
- Preparation of the operations manual for emergency situation
- Training to the operation staff for the emergency situation and disaster management

The Preliminary monitoring programmes for regular water quality monitoring are summarized in Table 17.2.9. The sampling and water quality analysis of raw water and distributed water will be carried out to check the performance of treatment plant and safety of water supply services.

Table 17.2.9 Preliminary Monitoring Programme

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

The result of IEE including adverse impacts and its mitigation or reduction measures for the environmental and social items is summarized in Table 17.2.10.

Table 17.2.10 Summary of Adverse Impacts and Mitigation Measures

No.	Environmental Items	Duration	Affected object	Potential Adverse Impact	Policy of Mitigation or Reduction Measures
1	Involuntary resettlement	-	-	**No Adverse Impact** The location of the water supply facilities was decided based on the water supply plan. The proposed project sites are located in public or private land without buildings.	
2	Local economy	Operation stage	Water venders	Considering the existing activities of water venders, adverse impacts to commercial activities of water vender are expected by implementation of water supply projects, and the business of water vender will be affected negatively.	To minimize adverse impact of project implementation on water venders in the target communes, proposed countermeasures are described below. 1) Promotion of employment Promotion of employment of water vender by providing seasonal or part-time job by the public corporation for O/M of water supply system is recommended. 2) Promotion of agricultural activity It is recommended that water venders return back to their original farming activities. In recent years, the farmers in this area have increased their income by retail sales of agricultural products. Considering this point, instruction of agricultural technology for cash crops is recommended. Since fundamental conditions of retail sales system have been already found, an increase in farmer's income can be expected and it contributes to regional economic development.
3	Land use and utilization of local resources	Permanent	Residents (Land user)	Some proposed sites are located in private agricultural lands, and disappearance of productive agricultural land is envisaged.	• In Vietnam, compensation of land expropriation in public projects such as water supply project is clearly prescribed by the Law on Land and Decree as below. • Persons whose land is acquired shall be compensated with new land that could be used for same purpose.

					• 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 acquisition decisions. • In case of compensation with new land or houses, if there is any difference in value, such difference shall be paid in cash. • It is expected that proper and sufficient compensation including the grant of an alternative agricultural land is carried out based on the Vietnamese law and regulation, and it can be judged that the adverse impact on land users shall be mitigated or eliminated.
5	Existing social infrastructures and services	Construction stage	Residents and passing car	Disruptions of vehicular and pedestrian traffic might occur during the construction stage of water supply system. Consideration is required about the following two points. - The principal means of transportation in rural area of Vietnam is motorbike rather than vehicles. During construction stage, occupancy of roads by distribution line construction activities shall affect normal traffic condition, and occurrence of traffic accident is also expected in the peak traffic hours particularly in morning and evening. - In the Cam Hai Tay (K-3), the national road divides the water service area proposed in this project, and a distribution line crosses the national road. Traffic congestion might occur on the national roads in the stage of distribution line lying.	These impacts could be mitigated or minimized by the following countermeasures: • The announcement and public notification • Watchman or traffic control staffs will be deployed at the site to control the traffic. • Temporary fences with appropriate warning signs should be used to isolate the construction site. • As mitigation measures, applying single-sided lane regulation and one-way traffic regulation for large cars is suitable for construction of the distribution line in the national road of Cam Hai Tay (K-3). • During the construction stage, the project owner or building constructor should arrange an information desk and a person responsible at the construction site office.
10	Water usage or water rights and rights of common	-	-	**No Adverse Impact** Of the nine systems selected in the feasibility study, six	

				systems utilize surface water as their water sources. Especially, three systems receive surface water from irrigation reservoir. Usually, the reservoir is highly utilized in the dry season. In consideration of this situation, utilization of the surface water in six water supply systems was deliberated by DARD and DONRE. Consequently, they judged that water supply projects do not influence the existing water rights and the water utilization from the reservoir is possible even in the dry season.	
15	Groundwater	-	-	**No Adverse Impact** The influence on groundwater was considered in the Master Plan. The communes for which groundwater quality was observed to be not suitable as drinking water or in cases when yield of groundwater was not enough were excluded from the group of target communes for the feasibility study. From the results of the test borehole drilling survey, P-4, P-8 and K-1 communes were selected as the target systems in the feasibility study in consideration of groundwater quality and productivity of groundwater. The characteristics of target aquifer of the boreholes in the water supply systems are quite different from the dug wells which most of villagers are using as source of water presently. Therefore, adverse impacts such as drawdown, seawater intrusion and so on, seem to be negligible.	
18	Flora, fauna and biodiversity	-	-	**No Adverse Impact** Ea Cha Rang commune (P-6) of the water supply system (FPG-4) is adjoining the Krong Trai Special-use	

				Forest. Water supply plan of FPG-4 was explained to DARD and DONRE in Phu Yen province. As a result, they concluded that there is no influence to the Special-use Forest by the construction of this water supply system.	
23	Water pollution	Operation stage	Residents	**No Adverse Impact** From the results of investigation, additional impact caused by this project is negligible. - Usually, villagers use water in the open air and wastewater is sprinkled over the yard. - Rainwater drainage canals /ditches of the dry season are dried, and wastewater is not seen in most of the drainage canals. (No wastewater is discharged into public water bodies) - There are no polluted water bodies by the domestic wastewater in the target communes.	From the existing disposal condition of domestic wastewater, additional impact caused by this project is negligible. However, installation of the simple treatment facilities (such as leaching pit) of domestic wastewater is recommended also from viewpoint of improvement of living environment in the future.
26	Noise and vibration	Construction stage	Residents	During construction works in the project, some noise and vibration will be generated by heavy equipments for construction. At present, there is no hospital, school, and private house in and around the proposed construction sites. Therefore, the influence of noise and vibration during construction work of the water supply facilities is minor or negligible.	These impacts will be limited to the construction period only and can be mitigated by adopting the following countermeasures: • Equipment maintenance should be strengthened to keep the noise level low. • Construction activities should be strictly prohibited at night such as between 8:00pm to 06:00am. (Actual time should be determined by the result of the stakeholder meeting or based on instruction from CPC.) • Polite operation and speed control are effective in reduction of the adverse impacts. • When required, a sound isolation wall is installed.
27	Land subsidence	-	-	**No Adverse Impact** The impact of groundwater withdrawal on land	

				subsidence was checked in the Master Plan. Appropriate withdrawal volume is designed for the water supply facility based on the pumping test results in the test boreholes drilling survey, and the target aquifer is fissure or weathered basement rocks. Therefore, there is no possibility of land subsidence.	
30	Accidents:	Construction stage Operation stage	Residents Others Users of water service	< War residual substance> War residual substances (dud bomb, mine, etc.) need to be eliminated before construction starts. < Contamination of raw water for water supply> Raw surface water source of water supply may be contaminated by accident.	< War residual substance> As countermeasures, it is necessary to make sure that clearance of war residual substances be carried out after land acquisition in this project. < Contamination of raw water for water supply> These impacts can be mitigated by adopting the following measures: • Implementation of regular water quality monitoring • Establishment of urgent communication network with the river administrator and related organization. • Preparation of the operations manual for emergency situation • Training to the operation staff for the emergency situation and disaster management

(4) Conclusion and Recommendation

Based on the findings of the IEE, the following items should be considered as mitigation measures for project implementation. However, the adverse impacts described below are minor, and if appropriate mitigation measures including proposed measures in this IEE are undertaken properly, these adverse impacts will be satisfactory controlled and mitigated.

Local economy (water vender)

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

To mitigate negative impact on these venders, it is proposed that they should be provided seasonal or part-time job by the water service corporation and they should be led to return to full time farming and household practices through agricultural promotion.

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

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

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

Existing social infrastructures and services (disruptions of traffic situation)

In the rural area of Vietnam, prime means of transportation is motorbike rather than vehicles. Therefore, during construction stage of distribution lines, occupancy of roads by construction activities shall affect normal traffic situation, and occurrence of traffic accident is also expected during peak traffic hours specially in morning and evening.

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

Water pollution (water pollution by domestic wastewater)

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

water pollution caused by implementation of water supply projects.

However, installation of the simple treatment facilities (such as leaching pit) of domestic wastewater is recommended also from viewpoint of improvement of living environment in the future.

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

During construction and operation stage of the water supply project, some accidents by the war residual substance and hazardous substance outflow are expected. As countermeasures, clearance of war residual substances is required to avoid any accidents due to war residual dud bombs, mines, etc. To avoid accident by hazardous substances due to water contamination of source, water quality monitoring, establishment of an urgent communication network and preparation of the operations manual for emergency situation are proposed.