7. 4 Operation and Maintenance Plan

7.4.1 Organization of the Institute

1) Basic Concept of the Institute in Charge of Water Supply System

Water supply service is one of the activities that are basically required for human lives especially in the urban. Therefore the service shall be managed in accordance with the national policy of social welfare and in general also be sustained by the principle that beneficiaries should pay for value of the service. That secures the service be managed eternally with good condition.

In accordance with the master plan formulated the above section, the water supply volume shall be increased from 23,000 m^3/day in 1998 to 49,800 m^3/day in 2015. And the water sources shall also be relied on mainly surface water in future. That means the organization required in future shall also function as similar as the present activities.

The organization in charge of water supply service has to cover the following activities.

a) Operation and maintenance of all the facilities on water intake, production, distribution, other related works

b) Study and planning

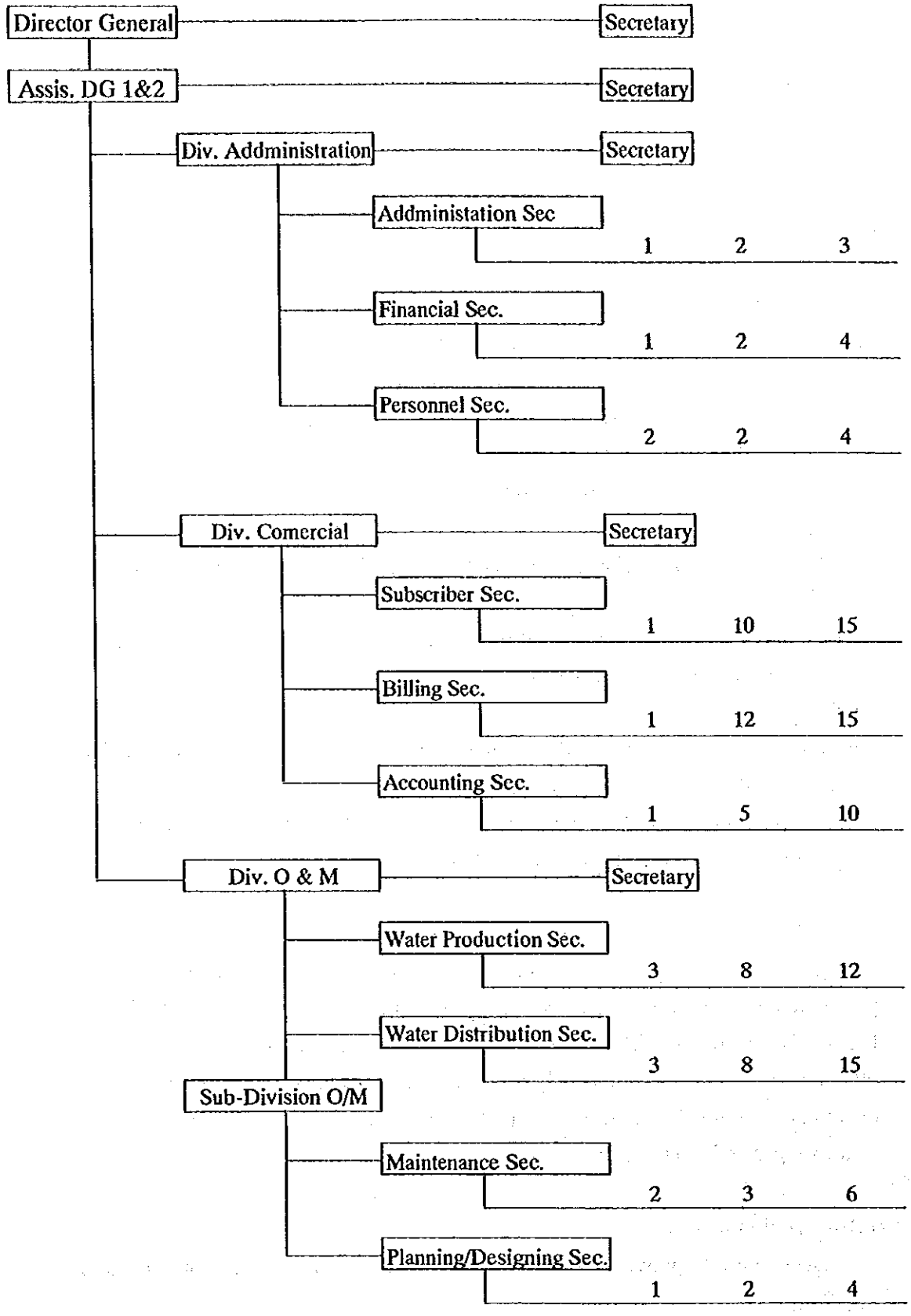
c) Commercial and public relation which is composed of registration of subscribers, meter read and billing to the subscribers.

d) Administration of itself which composed of general affair of the organization, personnel administration, financial administration etc.

Those activities are basically as same as the one which SODECA has been managed. Concerning augmentation of water supply volume and service population, the institutional empowerment of the organization is indispensable. Especially the commercial and public relation field is so important to support the other activities, because this is only financial source for the organization. The experiences of SODECA can be said to be applicable for all the aspects needed for water supply activities in future.

2) Organization in future

Depend on the above the organization needed in future shall be formulated in Fig. 7.4.1.



Number of Person

Category	Executive	Director	Section Chief	Sub-chief	Employee	Temporally Worker	Grand Total
Total	3	4	10	21	54	88	180

Fig. 7.4.1 Organization of the Institute

7.4.2 O/M Cost Estimation

Costs of operation and maintenance were estimated for the each case of two alternative plans as shown in Table 7.4.1(1) through 7.4.1(2) respectively depending on various break downs of financial items as follows.

1) Revenue of water sales

For estimation of water sales revenue, improvement of the "accounted-for water as percentage of total" in each zone was considered as follows.

* the whole Bangui & B1, B2 and B3:

Depend on SODECA's data Accounted-for water as percentage of total was 53.2% in 1997. The ratio was assumed to be improved linearly from 53 % in 1998 to 71 % in 2015, which means a 95 % of the effective water would contribute to earning water in 2015.

*B4 to B10 of Bimbo:

As these zone are new water supply area, an accounted-for water as percentage of total were estimated at 95 % of the effective water as same as the whole Bangui. Therefore it was calculated at 86% in 2005 and 81% in 2015. The years between them were assumed to decrease linearly.

*Price of water sale per m^3 was assumed as same as the present water supply basis of 391.6 FCFA in accordance with SODECA's data of year 1996 and 1997.

Revenue estimation is shown in Table 7.4.2.

2) Expenditures Estimation

Expenditures of personnel salary and allowances were estimated as shown in Table 7.4.3. The costs of electricity and chemicals were also estimated in Table 7.4.4. Depreciation of each alternative were shown in Table 7.4.5.

Table 7.4.1(1) Estimation of Balance of Sales Revenue amd O/M Cost

Projection of Operating Costs/Benefits:No.1

Breakdown	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Water Supply(m³/year)		7,462,686	7,552,371	7,642,057	7,731,743	7,821,429	7,911,114	8,000,800	8,557,060	9,113,320	9,669,580	10,225,840	10,782,100	11,533,270	12,284,440	13,035,610	13,786,780	14,537,950
Water Supply Compensated(m³/year)		4,034,240	4,162,689	4,293,038	4,425,286	4,559,433	4,704,622	4,842,048	5,273,404	5,715,870	6,169,446	6,634,132	7,109,928	7,733,670	8,371,385	9,023,074	9,688,736	10,368,373
Compensation(%)		54.1	55.1	56.2	57.2	58.3	59.5	60.5	61.6	62.7	63.8	64.9	65.9	67.1	68.1	69.2	70.3	71.3
Cost and Benefit Accounts / Revenue	1 .Operating Revenue																	
	Sales Revenue(Water Supply)	1,579,808	1,630,109	1,681,154	1,732,942	1,785,474	1,842,330	1,896,146	2,065,065	2,238,335	2,415,955	2,597,926	2,784,248	3,028,505	3,278,234	3,533,436	3,794,109	4,060,255
	Subsidies Base on Water Supply Volume																	
	Other Operating Revenue	190,013	196,063	202,202	208,431	214,749	221,588	228,060	248,377	269,217	290,581	312,468	334,878	364,256	394,292	424,987	456,339	488,350
	Subtotal (A)	1,769,821	1,826,172	1,883,356	1,941,373	2,000,223	2,063,918	2,124,206	2,313,442	2,507,552	2,706,536	2,910,394	3,119,126	3,392,761	3,672,526	3,958,422	4,250,449	4,548,605
	2 .Non-Operating Revenue																	
	Interest Income																	
	Miscellaneous Income																	
	Subtotal (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Income Total (A)+(B)=(C)	1,769,821	1,826,172	1,883,356	1,941,373	2,000,223	2,063,918	2,124,206	2,313,442	2,507,552	2,706,536	2,910,394	3,119,126	3,392,761	3,672,526	3,958,422	4,250,449	4,548,605
Expenditure	1 .Operating Expenses																	
	① Personnel Expenditure	753,731	762,790	771,848	780,906	789,964	799,023	808,081	864,263	920,445	976,628	1,032,810	1,088,992	1,164,860	1,240,728	1,316,597	1,392,465	1,468,333
	② Power/Chemicals Expenses	440,821	446,119	451,416	456,714	462,012	435,936	441,234	474,092	506,951	539,809	572,667	605,525	649,897	694,269	738,640	783,012	827,383
	③ Other Maintenance Costs	455,250	455,250	455,250	455,250	455,250	603,106	603,106	603,106	603,106	603,106	840,892	840,892	840,892	840,892	840,892	840,892	840,892
	④ Depreciation	607,000	607,000	607,000	607,000	607,000	804,141	804,141	804,141	804,141	804,141	1,121,189	1,121,189	1,121,189	1,121,189	1,121,189	1,121,189	1,121,189
	⑤ Wasting Assets																	
	Subtotal	2,256,802	2,271,158	2,285,514	2,299,870	2,314,226	2,642,206	2,656,562	2,745,602	2,834,643	2,923,683	3,567,558	3,656,598	3,776,838	3,897,078	4,017,318	4,137,557	4,257,797
	2 .Non-Operating Expenses																	
	⑥ Interest Expense																	
	⑦ Deferred Assets																	
	⑧ Other Non-Operating Expenses																	
	Subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	expenditure total (D)	2,256,802	2,271,158	2,285,514	2,299,870	2,314,226	2,642,206	2,656,562	2,745,602	2,834,643	2,923,683	3,567,558	3,656,598	3,776,838	3,897,078	4,017,318	4,137,557	4,257,797
Operating Profit/Loss (C)-(D) (E)		-486,981	-444,986	-402,158	-358,497	-314,003	-578,288	-532,355	-432,160	-327,091	-217,147	-657,164	-537,473	-384,077	-224,551	-58,895	112,891	290,808
Profit/Loss before Depreciation [E+(4)]		120,019	162,014	204,842	248,503	292,997	225,853	271,786	371,981	477,050	586,994	464,025	583,716	737,112	896,638	1,062,294	1,234,080	1,411,997
Special Loss (G)																		
Special Profit/Loss (H)																		
Net Annual Profit(Loss) (E)+(H)																		
Unit Cost of Water Supply (FCFA/m3)		302	301	299	297	296	334	332	321	311	302	349	339	327	317	308	300	293
Unit Sales Price of Water Supply (FCFA/m3)		559	546	532	520	508	562	549	521	496	474	538	514	488	466	445	427	411

▲ Completion of Groundwater Development Project

▲ Completion of Expansion Project of Existing Water Treatment Plant

Table 7.4.1(2) Estimation of Balance of Sales Revenue amd O/M Cost

Projection of Operating Costs/Benefits:No.2

Breakdown	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Water Supply(m3/year)		7,462,686	7,552,371	7,642,057	7,731,743	7,821,429	7,911,114	8,000,800	8,557,060	9,113,320	9,669,580	10,225,840	10,782,100	11,533,270	12,284,440	13,035,610	13,786,780	14,537,950
Water Supply Compensated(m³/year)		4,034,240	4,162,689	4,293,038	4,425,286	4,559,433	4,704,622	4,842,048	5,273,404	5,715,870	6,169,446	6,634,132	7,109,928	7,733,670	8,371,385	9,023,074	9,688,736	10,368,373
Compensation(%)		54.1	55.1	56.2	57.2	58.3	59.5	60.5	61.6	62.7	63.8	64.9	65.9	67.1	68.1	69.2	70.3	71.3
Cost and Benefit Accounts / Revenue	1 .Operating Revenue																	
	Sales Revenue(Water Supply)	1,579,808	1,630,109	1,681,154	1,732,942	1,785,474	1,842,330	1,896,146	2,065,065	2,238,335	2,415,955	2,597,926	2,784,248	3,028,505	3,278,234	3,533,436	3,794,109	4,060,255
	Subsidies Base on Water Supply Volume																	
	Other Operating Revenue	190,013	196,063	202,202	208,431	214,749	221,588	228,060	248,377	269,217	290,581	312,468	334,878	364,256	394,292	424,987	456,339	488,350
	Subtotal (A)	1,769,821	1,826,172	1,883,356	1,941,373	2,000,223	2,063,918	2,124,206	2,313,442	2,507,552	2,706,536	2,910,394	3,119,126	3,392,761	3,672,526	3,958,422	4,250,449	4,548,605
	2 .Non-Operating Revenue																	
	Interest Income																	
	Miscellaneous Income																	
	Subtotal (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Income Total (A)+(B)=(C)	1,769,821	1,826,172	1,883,356	1,941,373	2,000,223	2,063,918	2,124,206	2,313,442	2,507,552	2,706,536	2,910,394	3,119,126	3,392,761	3,672,526	3,958,422	4,250,449	4,548,605
Expenditure	1 .Operating Expenses																	
	① Personnel Expenditure	753,731	762,790	771,848	780,906	789,964	799,023	808,081	864,263	920,445	976,628	1,032,810	1,088,992	1,164,860	1,240,728	1,316,597	1,392,465	1,468,333
	② Power/Chemicals Expenses	440,821	446,119	451,416	456,714	462,012	435,936	441,234	474,092	506,951	539,809	572,667	605,525	649,897	694,269	738,640	783,012	827,383
	③ Other Maintenance Costs	455,250	455,250	455,250	455,250	455,250	603,106	603,106	603,106	603,106	603,106	871,351	871,351	871,351	871,351	871,351	871,351	871,351
	④ Depreciation	607,000	607,000	607,000	607,000	607,000	804,141	804,141	804,141	804,141	804,141	1,161,801	1,161,801	1,161,801	1,161,801	1,161,801	1,161,801	1,161,801
	⑤ Wasting Assets																	
	Subtotal	2,256,802	2,271,158	2,285,514	2,299,870	2,314,226	2,642,206	2,656,562	2,745,602	2,834,643	2,923,683	3,638,629	3,727,669	3,847,909	3,968,149	4,088,389	4,208,628	4,328,868
	2 .Non-Operating Expenses																	
	⑥ Interest Expense																	
	⑦ Deferred Assets																	
	⑧ Other Non-Operating Expenses																	
	Subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	expenditure total (D)	2,256,802	2,271,158	2,285,514	2,299,870	2,314,226	2,642,206	2,656,562	2,745,602	2,834,643	2,923,683	3,638,629	3,727,669	3,847,909	3,968,149	4,088,389	4,208,628	4,328,868
Operating Profit/Loss (C)-(D) (E)		-486,981	-444,986	-402,158	-358,497	-314,003	-578,288	-532,355	-432,160	-327,091	-217,147	-728,235	-608,544	-455,148	-295,622	-129,966	41,820	219,737
Profit/Loss before Depreciation [E+(4)]		120,019	162,014	204,842	248,503	292,997	225,853	271,786	371,981	477,050	586,994	433,566	553,257	706,653	866,179	1,031,835	1,203,621	1,381,538
Special Loss (G)																		
Special Profit/Loss (H)																		
Net Annual Profit(Loss) (E)+(H)																		
Unit Cost of Water Supply (FCFA/m3)		302	301	299	297	296	334	332	321	311	302	356	346	334	323	314	305	298
Unit Sales Price of Water Supply (FCFA/m3)		559	546	532	520	508	562	549	521	496	474	548	524	498	474	453	434	418

▲ Completion of Groundwater Development Project

▲ Completion of Project of New Intake& Water Treatment Plant

Table 7.4.2 Estimation of Revenue of Water Sales

year	Mean Supply Water Volume		Bangui City+B1～B 3		B 4 ～B10		Total Volume of Revenue Earnig Water		Water Sales Revenue	
	Mean Daily	Anually	Alocated Mean Supply Water Volume	Revenue Earning Water Volume	Alocated Mean Supply Water Volume	Revenue Earning Water Volume	Volume	Total Ratio of Revenue Earning Water	Mean Unit Cost for Water Supply	Total Income
	(m3/day)	(m3／year)	(m3／year)		(m3／year)		(m3／year)	(%)	(FCFA/m3)	(K-FCFA)
1998	20,200	7,373,000	7,373,000	3,907,690		0	3,907,690	53.0	391.6	1,530,251
1999	20,446	7,462,686	7,462,686	4,034,240		0	4,034,240	54.1	391.6	1,579,808
2000	20,691	7,552,371	7,552,371	4,162,689		0	4,162,689	55.1	391.6	1,630,109
2001	20,937	7,642,057	7,642,057	4,293,038		0	4,293,038	56.2	391.6	1,681,154
2002	21,183	7,731,743	7,731,743	4,425,286	0	0	4,425,286	57.2	391.6	1,732,942
2003	21,429	7,821,429	7,821,429	4,559,433	0	0	4,559,433	58.3	391.6	1,785,474
2004	21,674	7,911,114	7,876,804	4,675,115	34,310	29,507	4,704,622	59.5	391.6	1,842,330
2005	21,920	8,000,800	7,966,490	4,812,697	34,310	29,351	4,842,048	60.5	391.6	1,896,146
2006	23,444	8,557,060	8,500,632	5,225,388	56,428	48,015	5,273,404	61.6	391.6	2,065,065
2007	24,968	9,113,320	9,034,774	5,649,391	78,546	66,478	5,715,870	62.7	391.6	2,238,335
2008	26,492	9,669,580	9,568,916	6,084,705	100,664	84,741	6,169,446	63.8	391.6	2,415,955
2009	28,016	10,225,840	10,103,058	6,531,330	122,782	102,802	6,634,132	64.9	391.6	2,597,926
2010	29,540	10,782,100	10,637,200	6,989,266	144,900	120,662	7,109,928	65.9	391.6	2,784,248
2011	31,598	11,533,270	11,324,494	7,560,765	208,776	172,904	7,733,670	67.1	391.6	3,028,505
2012	33,656	12,284,440	12,011,788	8,146,819	272,652	224,566	8,371,385	68.1	391.6	3,278,234
2013	35,714	13,035,610	12,699,082	8,747,426	336,528	275,647	9,023,074	69.2	391.6	3,533,436
2014	37,772	13,786,780	13,386,376	9,362,589	400,404	326,147	9,688,736	70.3	391.6	3,794,109
2015	39,830	14,537,950	14,073,670	9,992,306	464,280	376,067	10,368,373	71.3	391.6	4,060,255

Table 7.4.3 Estimation of Expenditure of Personnel Salary and Allowance

year	Mean Water Supply Volume		Saraly	Allowance	Total	Remark
	m3／day	m3／year	@71FCFA	@30FCFA	(FCFA/year)	
1998	20,200	7,373,000	523,483,000	221,190,000	744,673,000	
1999	20,446	7,462,686	529,850,686	223,880,571	753,731,257	
2000	20,691	7,552,371	536,218,371	226,571,143	762,789,514	
2001	20,937	7,642,057	542,586,057	229,261,714	771,847,771	
2002	21,183	7,731,743	548,953,743	231,952,286	780,906,029	
2003	21,429	7,821,429	555,321,429	234,642,857	789,964,286	
2004	21,674	7,911,114	561,689,114	237,333,429	799,022,543	
2005	21,920	8,000,800	568,056,800	240,024,000	808,080,800	
2006	23,444	8,557,060	607,551,260	256,711,800	864,263,060	
2007	24,968	9,113,320	647,045,720	273,399,600	920,445,320	
2008	26,492	9,669,580	686,540,180	290,087,400	976,627,580	
2009	28,016	10,225,840	726,034,640	306,775,200	1,032,809,840	
2010	29,540	10,782,100	765,529,100	323,463,000	1,088,992,100	
2011	31,598	11,533,270	818,862,170	345,998,100	1,164,860,270	
2012	33,656	12,284,440	872,195,240	368,533,200	1,240,728,440	
2013	35,714	13,035,610	925,528,310	391,068,300	1,316,596,610	
2014	37,772	13,786,780	978,861,380	413,603,400	1,392,464,780	
2015	39,830	14,537,950	1,032,194,450	436,138,500	1,468,332,950	

Table 7.4.4 Estimation of Costs of Electricity and Chemicals

	Supply Water Volume	Water Supply Volume by Water Treatment Plant			Water Supply Volume by Wells			
year	Total (m3/year)	Volume	Unit price CFA/m3	Expenditure K.CFA/year	Volume	Unit price CFA/m3	Expenditure K.CFA/year	Total
1998	7,373,000	7,373,000	59.07	435,523	0		0	435,523
1999	7,462,686	7,462,686	59.07	440,821	0		0	440,821
2000	7,552,371	7,552,371	59.07	446,119	0		0	446,119
2001	7,642,057	7,642,057	59.07	451,416	0		0	451,416
2002	7,731,743	7,731,743	59.07	456,714	0		0	456,714
2003	7,821,429	7,821,429	59.07	462,012	0		0	462,012
2004	7,911,114	7,108,114	59.07	419,876	803,000	20	16,060	435,936
2005	8,000,800	7,197,800	59.07	425,174	803,000	20	16,060	441,234
2006	8,557,060	7,754,060	59.07	458,032	803,000	20	16,060	474,092
2007	9,113,320	8,310,320	59.07	490,891	803,000	20	16,060	506,951
2008	9,669,580	8,866,580	59.07	523,749	803,000	20	16,060	539,809
2009	10,225,840	9,422,840	59.07	556,607	803,000	20	16,060	572,667
2010	10,782,100	9,979,100	59.07	589,465	803,000	20	16,060	605,525
2011	11,533,270	10,730,270	59.07	633,837	803,000	20	16,060	649,897
2012	12,284,440	11,481,440	59.07	678,209	803,000	20	16,060	694,269
2013	13,035,610	12,232,610	59.07	722,580	803,000	20	16,060	738,640
2014	13,786,780	12,983,780	59.07	766,952	803,000	20	16,060	783,012
2015	14,537,950	13,734,950	59.07	811,323	803,000	20	16,060	827,383

Table 7.4.5 Estomation of Depreciation of the Alternative Project (Unit : 1000FCFA)

	Components of sub-project	Construction Year	Project Cost	Calculation of Depreciation				Term of Depreciation
				Real Value	Life year	Ratio	Result	
			A	Ax0.9				
Alternative 1	Groundwater Development Project	2001～2003	3,533,000	3,179,700	16	0.062	197,141	2004～2019
	Expansion of the Ex. Water Treatment Plant	2006～2008	14,091,000	12,681,900	40	0.025	317,048	2009～2048
	Total		17,624,000	15,861,600			514,189	
Alternative 2	Groundwater Development Project	2001～2003	3,533,000	3,179,700	16	0.062	197,141	2004～2019
	Construction of new Intake & Water Treatment Plant	2006～2008	15,896,000	14,306,400	40	0.025	357,660	2009～2048
	Total		19,429,000	17,486,100			554,801	

7.4.3 Sanitation Improvment Plan

Parasite disease, malaria, and diarrheal disease are the most common diseases in CAR. All of them are water born diseases and the most serious mortal disease. Improvement of water supply and related activities including sanitation/ Hygiene education can improve such condition notably.

1) Improvement of sanitation

Water supply project and sanitation improvement are close related. However many cases sanitation is put to a second place in water supply projects.

Sanitation and hygiene improvement together with improvement of water quality make a great effect on diarrhoeal diseases, which are the most prevalent water and sanitation disease and the first mortal cause for children below five years of age. Sanitation and hygiene improvement together with improvement of water quality are the three most effective solution to reduce diarrhoeal disease.

Sanitation programme will be most effective if it fits to the demand to the people. The project will work to mobilise sanitation demand or create demand where it does not yet exist. The overall objective is to develop a strategy for improving sanitation which, once established, households, communities and the private sector will sustain by themselves.

There are a number of sanitation programmes which are more demand responsive than supply driven. They are the programmes not only supply sanitation equipment but also to mobilise or create demands. As a result these projects shows far more willingness and ability to pay for sanitation and in sharp contrast to experiences with a supply-driven strategy.

The degree of demand is strongly related to the local physical and socio-cultural environment. Demands increase when the local situation creates problems , or when potential users come into contact with attractive solutions. Gender factors indicates a different demand for women and men. For example, women have higher demand of latrines than men because women have more problem with lack of privacy, distance and safety.

2) Sanitation / Hygiene Awareness Behaviour among Population in Project Area

The studies done by questioners and interview can indicate sanitary/hygienic awareness and behaviour.

In the questioner in 1996, the result of water related disease (like Diarrhoea and Parasite) awareness is generally high (See Fig. 7.4.2) . The findings are following:

- in total, 58% of people are aware of Diarrhoea
- as high as 97.5 people are aware of Parasite as water related disease.
- the result of ORS (oral re-hydration solution) awareness indicate relatively high result. In total, it is 47%. However it varies from places to place. Clearly rural where less sanitation/ hygiene education is run, it is poorer. The result excluding rural area is 57%.

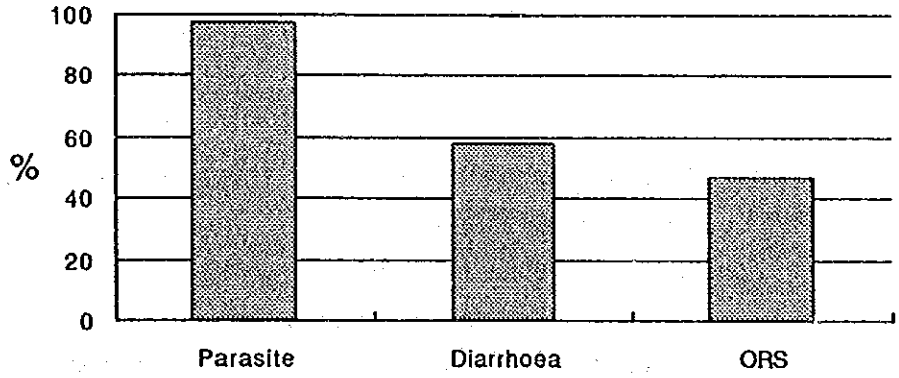


Fig.7.4.2 Sanitation awareness

Fig. 7.4.3 shows the Gender and age difference in ORS awareness, attendance of Sanitation/ Hygiene Education (SHE) and attendance of community work (CW).

(the result from 1996 questioner , percentage in positive answer)

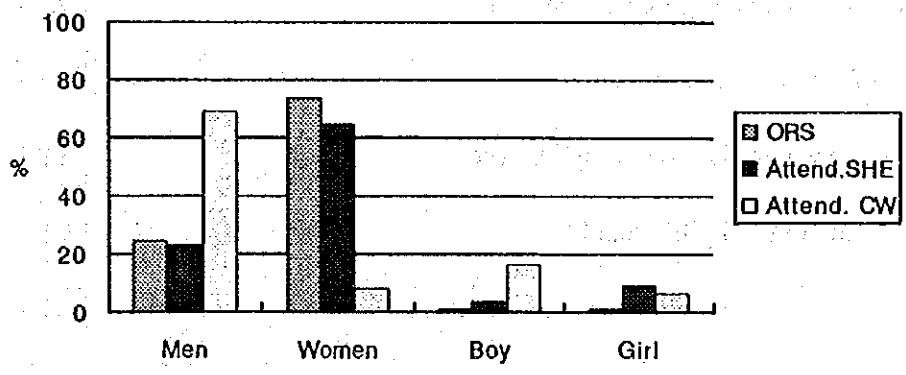


Fig. 7.4.3 Gender difference

The findings are following:

- ORS awareness is far higher among women than men.
- also attendance of Sanitation/ Hygiene Education is higher than men. There is tendency that women are in charge of getting information about sanitation/ hygiene and practice at home.
- However attendance of women in community work is low. It is due to the type of the community work. Work is mainly physical work like construction and maintenance. There is a possibility to extend community work in sanitation/ hygiene to encourage women's participation, such as Sanitation/ Hygiene Education.

For the improvement of sanitation, behaviour change comes first. To see the present situation, Sanitary/ Hygiene behaviour was examined. Table shows Sanitary/ Hygienic behaviour scores from the questioner done 1996. It is calculated how many percentage of interviewee practice recommended methods .

The findings are following:

- No.1-1, No.1-4, No.1-5 behaviours are particularly low. However No.1-1 behaviour can be improved easily by giving adequate information.
- No.1-4 and No.1-5 behaviours are related to insufficient service. Individuals are not well informed, therefore they do not strictly follow regulation.
- High result of No.1-6 indicates that usage of latrine is already having status

Table 7.4.6 Sanitation/ Hygiene Behaviour Score

No.	Sanitary / Hygienic Behaviour	Score
1- 1	Covered water container	31.5
1- 2	Covering cooked food during storage	55
1- 3	Kitchen utensils stored off the floor	78.5
1-4	Rubbish buried or burned	29.5
1-5	Waste water disposed in drain/ hole	34.5
1-6	Latrine in use by household	94
1-7	Latrine in use by all household members	84.7

In supplemental study, the households are divided into groups according to the water source. First using private connection (Group A), second group (Group B) and third group consists of 16 household using no private connection or kiosque (Group C). Following is additional Sanitary/ Hygienic behaviour scores related to water of each group. There is interesting difference within groups.

Table 7.4.7 Difference behaviour within Groups

No.	Sanitary / Hygienic Behaviour	Score A	B	C
2-1	Hand-washing after defecating	80	70	62.5
2-2	Hand-washing before cooking	86.7	75	75
2-3	Not eating unwashed raw fruits and vegetables	100	90	93.8
2-4	Waste water disposed in drain/ hole, vegetable garden	13	15	37

The findings are following:

- The scores of behaviour No.2-1, 2-2, 2-3 , Group B, C people are lower than Group A, reluctant to use potable water more than drinking and cooking due to more difficulty to get.
- Score of Group C in No.2-4 shows highest, it is assumed that Group C people live more in sub-urban area and having more vegetable garden to re-use waste water.

3. Sanitation/Hygiene Improvement Project Practised in Bangui

There are few Sanitation/Hygiene projects run in Bangui by international organisation and/or NGO. UNICEF is organising a project through primary schools. International NGO such as Afri-care and CALITUS are running also projects at minor level.

Community Health Centres are main provider of health / sanitation service among the population. Since the Government of CAR practices according to Bamako Initiative (see box), those Community Centres are basically run by community, through locally elected committee. They provide initial treatment , Mother and Child care and Sanitation/Hygiene Education/ information. In Bangui, there are 13 Community Health Centres.

Box Bamako Initiative

The objective of Bamako Initiative is to promote health care for everybody in more cost effective way. It is based on the idea of the community self-financing for Primary Health Care (PHC).

Sanitation/Hygiene Education is widely done by Community Health Workers. There are two ways, first way Community Health Workers go around households or compounds and give instruction on health and sanitation, second way, Community Health Worker organise courses to the people who come to the Community Health Centre for miner treatment. In the first way, it is easy for the target group to access information. However since the number of Community Health Workers is limited, extension is strained. For second way, relatively a larger number of people can get information, however it is not possible to select target group. Shortage of extension materials including, training kids, panels and hand-outs is problem.

Box is typical one session of the course organised in a Community Health Centre. A Community Health Centre plan daily program monthly on the topic as Child Care, Malaria Hygiene, Family Planning, AIDS, vaccinations and etc.

Box:
Example of community Sanitation/Hygiene Education

This is Community Education done in Boy-Labe Community Health Centre

Target Group: Community people come to the centre for minor treatment
Time: 7:30 - 8:00 Daily before their treatment start
Revenue : Boy- Labe Community Centre waiting space
Objectives: To understand importance of sanitation/ prevention of disease in daily manner

Material to be used: serial Pictures, hand-out in Sango
Trainer: Community Health Worker

Activities: 1. Trainer explains about diseases
2. Trainer explains about cause of diseases come
3. Trainer explain how to prevent
4. Trainer explain how to prepare those materials to prevent disease
5. Trainer asks general questions

All the time, trainer uses serial of pictures and tries to interact with audience
Materials are provided by IEC (Information Education Centre under the Ministry of Public Health and Population) and Community Centre it self.

The WHO is promoting Information and Education Communication (IEC) in world wide. The objective of IEC is transform Sanitation/Hygiene information to the population effective way. They consider that local culture and custom is very important aspect in this field, particularly for participation of local people in Sanitation/Hygiene projects. IEC has a central station in Bangui and local stations at national level. Community Health Centres are retails of activities. IEC provides information, educational material (Video, Picture box and Panels) and in-service training to community health workers. Community Health Centre can get these input through local centres. IEC also conduct some studies for Sanitation/Hygiene projects.

4) Sudgestion to Sanitation/Hygiene Improvement in Project

To improve sanitation/ hygiene condition, sanitation/ hygiene promotion activities are essential together with infrastructure input. Following is the suggestion to the programme.

- There are some resources to give such education in Bangui, however it is not sufficient. The first problem is that the information/ knowledge to be handed out to population is not well organised and sometimes in shortage. Usage of IEC must be more encouraged. Cheaply produced local material for course / training must be encouraged , which can be more audience friendly especially in the linguistic point of view.
- The method to extend information must be reconsidered. Currently, sanitation/ hygiene education is done through Community Health Centres and Community Health workers' extension activities. It can be also efficient with other methods. For example, it can be briefer and more efficient to train some community representative (especially women) and to extend the information through them. This method can also create community development awareness.
- The extension worker / trainer of these activities must be better trained. Well trained extension workers / trainers are essential to effective sanitation/ hygiene promotion activities.

In addition, the approach which UNICEF is going to practice is instructive. It is sanitation/ hygiene education through primary schools. Recently it is known as Child to Child approach. In fact, children are the important target group and inter-media to give sanitation/ hygiene information. They themselves practice for sanitation/ hygiene improvement that is already very important progress since most common diseases can be prevented by sanitary hygienic care. More over, children in CAR are generally having a lot of task in house hold, such as water collection and taking care of smaller children. Though those activities, they can pass important message to each other.

7.4.4 Monitoring Plan

The purpose of the groundwater monitoring is to make the groundwater development be sustainable by observing the groundwater level and quality. In case that the regional draw-down of the groundwater level will become greater than the expected value or the discharged groundwater quality will get worse, the countermeasures which are for instance the stoppage of the water supply or moving the well fields to other areas must be undertaken immediately.

Since the groundwater recharge area is located in the urban area under the development, both of the quantity and quality of the groundwater is anticipated to change according to the urban development in future. Namely, the recharge amount to the groundwater will decrease because of the non-infiltration area such as roads and buildings will expand as a result of urban development. It is also supposed that the groundwater quality will deteriorate by the increase of the infiltration amount of the sewage drained from the household and factories which will be increasing every year.

As the groundwater development in the urban area has disadvantage in terms of both of quantity and quality as stated above, the groundwater monitoring should be closely continued on the quantity (groundwater level) and quality of the groundwater.

(1) Monitoring Plan of the Groundwater Level

As discussed in chapter 5.7, the groundwater level of the traditional shallow wells will decrease by the deep groundwater development and the development amount is proposed to be restricted less than 0.8MCM/year so as not to make the existing traditional shallow wells be dried up. However, the proposed groundwater development amount in this Study is estimated through the numerical examination based on the limited study results and the recharge amount is anticipated to decrease in future as mentioned above, the groundwater level monitoring is indispensable for the sustainable groundwater development.

The groundwater level monitoring should be conducted not only on the deep wells but also on the traditional shallow wells. The monitoring wells of the groundwater level and monitoring frequency is proposed in next table.

Table 7.4.8 Proposed Monitoring Wells for the Groundwater Level Observation

Well Type	Well No.	Monitoring Frequency, Method	Location, Coordinates
Deep Well	EW-6	Everyday by automatic recorder	Boeing, N4° 23′ 38″ ,E18° 23′ 38″
	EW-9	-ditto-	Pelemongo, N4° 21′ 58″ ,E18° 31′ 28″
	EW-12	-ditto-	Plateau, N4° 20′ 25″ ,E18° 31′ 25″
	EW-13	-ditto-	Pala, N4° 19′ 15″ ,E18° 31′ 59″
	EW-19	-ditto-	Ngouciment, N4° 22′ 18″ ,E18° 32′ 20″
	EW-20	-ditto-	Bakongo, N4° 21′ 23″ ,E18° 33′ 14″
	DW-18	Once a month by dip meter	Kpetenel, N4° 24′ 19″ ,E18° 34′ 04″
Traditional Shallow Well	SW-10	Once a month by dip meter	Nzangognan, N4° 21′ 18″ ,E18° 32′ 15″
	SW-24	-ditto-	Bakongo, N4° 21′ 47″ ,E18° 33′ 42″
	SW-29	-ditto-	Ramandow, N4° 23′ 10″ ,E18° 32′ 13″
	SW-31	-ditto-	Galabadja3, N4° 23′ 59″ ,E18° 32′ 33″
	SW-45	-ditto-	Boeing, N4° 22′ 53″ ,E18° 31′ 14″
	SW-47	-ditto-	Boeing, N4° 24′ 15″ ,E18° 30′ 51″

Hearing survey concerning the groundwater level of the shallow wells and existence of dried wells should also done in the vicinity of the monitoring wells simultaneously.

The results of the groundwater monitoring should be summarized in Table 7.4.8 and groundwater fluctuation curves. The location of the proposed monitoring wells listed above is shown in Fig.7.4.4.

(2) Monitoring Plan of the Groundwater Quality

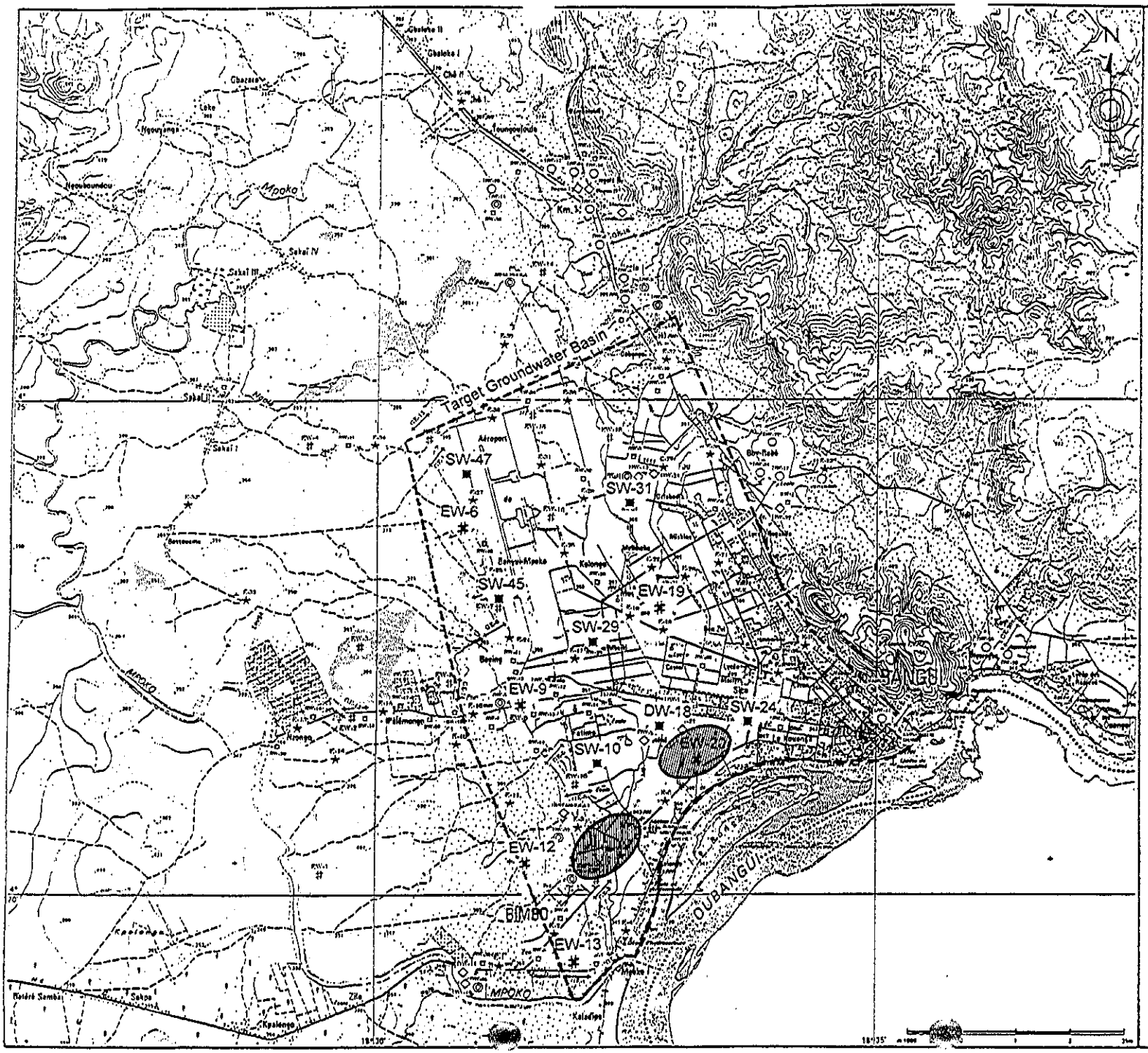
As discussed before, there is the possibility that the groundwater quality in the well fields will deteriorate in the course of the groundwater development because the recharge area of the groundwater is situated in the densely populated area where the urban development is still under the progress. Therefore, the groundwater quality monitoring must be regularly conducted on the discharged groundwater in the well fields.

The proposed monitoring frequency and monitoring items are as follows:

i. Subject wells for water quality monitoring : All of the production wells

ii. Frequency of the water quality monitoring :
- During two months after the development----------Once a week
- From two months to six months after the development----------Twice a month
- From six months to the end of the project after the development-------Once a month

iii. Monitoring items : pH, Temperature, Electric conductivity, Hardness, NO_3, NH_4, SO_4, Mn, Fe, Cl, Ca, Mg, K, E. Coliform



LEGEND

✱: Groundwater Level Observation Well by the Automatic Recoeder

✱: Groundwater Level Observation Well by the Dip Meter (by hand)

Proposed Well Field

Fig.7.4.4
Location of the Proposed Monitoring Wells for Groundwater Level Observation

7.5 Project Appraisal[1]

According to the project planning criteria, stated in preceding chapters, this project of ground-water development in Bangui has two major steps of benchmark: (1) completion of construction/expansion of boreholes and existing-intake & purification facilities in the year 2005, responding to the urgent need of safe water in the target area of F/S; (2) fulfillment of the goals of water-supply ratio (70 liters / person a day for private-connection customers, 25 liters / person a day for public-faucet customers with 100% water service in whole Bangui, Bimbo-1, 2 & 3; 60% in Bimbo-4, 5, 6 & 7; 50% in Bimbo-8, 9 & 10) in the year 2015, covering all the target areas of M/P.

In the following, three different Master Plans presented at Chapter 7.2.3 through Chapter 7.2.5 will be appreciated financially, economically and socially.[2] The project-life period is assumed as 20 years after completion of the construction, that is, the year 2033 is the last year of the project.

Benefits (both financial and economic) of the project and operational & maintenance (O&M) costs are annually appropriated.

Cost for land purchase is eliminated from calculation because, according to the master plans, most of all construction sites are located in desolated land and some possible constructions to be held in town can be expected to possess quite little portion of the project.

And discount rate applied for calculation of Present Value (of the project's financial/economic costs and revenue) is presumed 12%, as a logically and empirically persuasive rate of return to calculate opportunity benefit and cost of investment, based upon discussion with CAR authorities.

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[1] A strict rule of technical-term application is employed in this report; "appraisal" is for the preliminary checking, analysis and appreciation before project implementation, while "evaluation" is regarded as judgment based upon performance observation after the project is finished.

[2] Social appraisal of the project will be expressed in a comprehensive manner because the social background is a common factor in all M/P alternatives.

7.5.1 Financial Appraisal

(1) Methodology

The financial aspect of the project is appreciated in the manner of Financial Internal Rate of Return (FIRR).

The volume of water supply during the project life, the most important calculation factor on which many other accounts of cost/benefit based, is estimated by the operational planning staff of the JICA study team referring to actual figures of SODECA's service in the past.

Only costs and benefits that will be generated by the new investment project is to be an object of appreciation. Therefore, any cost or benefit to be attributed to the existing facilities/systems was eliminated as logically as possible. Basic formula is as follows:

[Net Water Supply by New Facilities] = [Gross Water Supply in Bangui / Bimbo] - [Original SODECA Distribution] (see Table 7.5.1).

In terms of the production, 70% of the capacity of a newly constructed facility is assumed to be utilized in the first year after completion. The ratio of the utilization will be increased by 10% annually, and reach to full capacity in the fourth year after completion. Production in the original SODECA facility would be adjusted in order to meet the demand of each year by the production in new facilities and the original SODECA facilities.

(a) Project Cost

The construction cost (initial investment amount) is based upon the project planning alternatives and equally allocated to each year during the construction period (see Table 7.5.2 "Project Costs of Construction by Alternative Master Plans").

Replacement costs are reckoned just after the end of durable years of the installed facilities (constructed assets of borehole: 16 years, others: 40 years) and residual value of the facilities are booked as negative costs at the period following the last year of the project (see Table 7.5.3 "Replacement Cost and Residual Value of Investment at the End of the Project Life").

Table 7.5.1 Calculation for Net Water Supply, Operating Revenue and Personnel Expenditure of the Project

(Unit: -000- FCFA, unless otherwise noted)

Year	Gross Water Supply in Bangui / Bimbo (m^3/year)	Original SODECA Distribution (m^3/year)	Net Water Supply by New Facilities (m^3/year)	Compensation Rate (%)	Water Supply Compensated (m^3/year)	Sales Revenue	Other Operating Revenue	Total Operating Revenue	Personnel Expenditure
2000	7,552,371	7,552,371	0	55.1	0	0	0	0	0
2001	7,642,057	7,642,057	0	56.2	0	0	0	0	0
2002	7,731,743	7,731,743	0	57.2	0	0	0	0	0
2003	7,821,429	7,821,429	0	58.3	0	0	0	0	0
2004	7,911,114	7,349,014	562,100	59.5	334,307	130,915	15,710	146,625	56,772
2005	8,000,800	7,358,400	642,400	60.5	388,815	152,260	18,271	170,531	64,882
2006	8,557,060	7,834,360	722,700	61.7	445,556	174,480	20,938	195,417	72,993
2007	9,113,320	8,310,320	803,000	62.8	503,920	197,335	23,680	221,015	81,103
2008	9,669,580	8,866,580	803,000	63.8	512,643	200,751	24,090	224,841	81,103
2009	10,225,840	6,438,600	3,787,240	64.9	2,458,468	962,736	115,528	1,078,265	382,511
2010	10,782,100	6,568,540	4,213,560	66.0	2,780,029	1,088,659	130,639	1,219,298	425,570
2011	11,533,270	6,893,390	4,639,880	67.1	3,112,345	1,218,794	146,255	1,365,050	468,628
2012	12,284,440	7,218,240	5,066,200	68.2	3,452,921	1,352,164	162,260	1,514,423	511,686
2013	13,035,610	7,969,410	5,066,200	69.2	3,506,672	1,373,213	164,786	1,537,998	511,686
2014	13,786,780	8,720,580	5,066,200	70.3	3,559,751	1,393,999	167,280	1,561,279	511,686
2015	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2016	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2017	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2018	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2019	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2020	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2021	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2022	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2023	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2024	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2025	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2026	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2027	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2028	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2029	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2030	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2031	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2032	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686
2033	14,537,950	9,471,750	5,066,200	71.3	3,612,296	1,414,575	169,749	1,584,324	511,686

(Source: Statistics of SODECA and Projection by Operation Planning Staff of the JICA Study Team)

Table 7.5.2 Project Costs of Construction by Alternative Master Plans

(Unit: -000- FCFA)

Alternative 1: Expansion of the Existing Water Treatment Plant

Year	Description of Construction	Investment Amount	Annual Cost
2001 - 2003	Borehole + Reservoir + Distribution Pipe Construction	3,533,000	1,177,667
2006 - 2008	Expansion of Existing Purification Plant	14,091,000	4,697,000
Alternative 1 Total		**17,624,000**	

Alterntive 2: New Intake + Purification Plant

Year	Description of Construction	Investment Amount	Annual Cost
2001 - 2003	Borehole + Reservoir + Distribution Pipe Construction	3,533,000	1,177,667
2006 - 2008	Expansion of Existing Purification Plant	15,896,000	5,298,667
Alternative 2 Total		**19,429,000**	

Table 7.5.3 Replacement Cost and Residual Value of Investment at the End of the Project Life

(Unit: -000- FCFA)

Alternative 1: Expansion of the Existing Water Treatment Plant

Years of Construction	Description of Construction	Investment Amount	Durable Years	Year of Replacement	Residual Years at the end of P/L	Residual Value at the End of P/L
2001 - 2003	Borehole + Reservoir + Distribution Pipe Construction	3,533,000	16	2019	2	441,625
2006 - 2008	Expansion of Existing Purification Plant	14,091,000	40	(N/A)	15	5,284,125
Alternative 1 Total		**17,624,000**		**Residual Value Total**		5,725,750

Alterntive 2: New Intake + Purification Plant

Year	Description of Construction	Investment Amount	Durable Years	Year of Replacement	Residual Years at the end of P/L	Residual Value at the End of P/L
2001 - 2003	Borehole + Reservoir + Distribution Pipe Construction	3,533,000	16	2019	2	441,625
2006 - 2008	Expansion of Existing Purification Plant	15,896,000	40	(N/A)	15	5,961,000
Alternative 2 Total		**19,429,000**		**Residual Value Total**		6,402,625

O&M costs, comprising (a) personnel, (b) power/chemicals expenses and (c) other miscellaneous maintenance costs, are respectively estimated by the operation planning staff of the JICA study team in the following manners: (a) [Compensated Water-Supply Volume (m^3)] multiplies [Deduced Unit Cost of Personnel from Actual Figures of SODECA (=@101 FCFA/m^3)] (see Table 7.5.1 "alculation for Net Water Supply, Operating Revenue and Expenditure of the Project"); (b) [Compensated Water-Supply Volume (m^3)] multiplies [Deduced Unit Cost of Power/ Chemicals from Actual Figures of SODECA] (see Table 7.5.4(1) through 7.5.4(3) "Calculation for Power / Chemicals Expenses of the Project"); (c) [Planned Depreciation Amount per Year] multiplies 0.75 (see Table 7.5.5 "Calculation for Miscellaneous Maintenance Costs by Alternative Master Plans").

(b) Project Revenue

Each project year's operational revenue is estimated by the operation planning staff of JICA study team based upon actual performance of SODECA's water distribution vis-à-vis charges collected in the past. The calculation formula is as follows:
[Water Supply Compensated (m^3)] multiplies [Unit Cost of Water Sales (=@391.6 FCFA/m^3)] (see Table 7.5.1 .)

(c) Projects to be Appreciated

As mentioned before, three alternatives of M/Ps are presented (see Table 7.5.2). The difference between those projects is attributed to the construction portion. As far as the operational revenue is concerned, however, since covering service areas of the project and targets (e.g. rate of water supply to consumers by district, total distribution volume per year, etc.) are common, just one case of revenue earning is applied to all the alternative plans (see Table 7.5.1 and Table 7.5.6 "Financial Internal Rate of Return (FIRR) by Alternative Master Plans).

Table 7.5.4(1) Calculation for Power / Chemicals Expenses of the Project (M/P 1)

(Unit: -000- FCFA, unless otherwise noted)

Year	Total Water Supply by New Facilities (m^3/year)	Water Supply by Boreholes (m^3/year)	Power/Chem. Unit Cost (FCFA)	Power/Chem. Expense of Boreholes	Supply by Purification (m^3/year)	Power/Chem. Unit Cost (FCFA)	Power/Chem. Expense of Purification	Total Power/Chem. Expenses
2000	0	0	20	0	0	59.07	0	0
2001	0	0	20	0	0	59.07	0	0
2002	0	0	20	0	0	59.07	0	0
2003	0	0	20	0	0	59.07	0	0
2004	562,100	562,100	20	11,242	0	59.07	0	11,242
2005	642,400	642,400	20	12,848	0	59.07	0	12,848
2006	722,700	722,700	20	14,454	0	59.07	0	14,454
2007	803,000	803,000	20	16,060	0	59.07	0	16,060
2008	803,000	803,000	20	16,060	0	59.07	0	16,060
2009	3,787,240	803,000	20	16,060	2,984,240	59.07	176,279	192,339
2010	4,213,560	803,000	20	16,060	3,410,560	59.07	201,462	217,522
2011	4,639,880	803,000	20	16,060	3,836,880	59.07	226,645	242,705
2012	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2013	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2014	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2015	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2016	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2017	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2018	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2019	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2020	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2021	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2022	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2023	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2024	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2025	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2026	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2027	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2028	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2029	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2030	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2031	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2032	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2033	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887

(Source: Statistics of SODECA and Projection by Operation Planning Staff of the JICA Study Team)

Table 7.5.4(2) Calculation for Power / Chemicals Expenses of the Project (M/P 2)

(Unit: -000- FCFA, unless otherwise noted)

Year	Total Water Supply by New Facilities (m^3/year)	Water Supply by Boreholes (m^3/year)	Power/Chem. Unit Cost (FCFA)	Power/Chem. Expense of Boreholes	Supply by Purification (m^3/year)	Power/Chem. Unit Cost (FCFA)	Power/Chem. Expense of Purification	Total Power/Chem. Expenses
2000	0	0	20	0	0	59.07	0	0
2001	0	0	20	0	0	59.07	0	0
2002	0	0	20	0	0	59.07	0	0
2003	0	0	20	0	0	59.07	0	0
2004	562,100	562,100	20	11,242	0	59.07	0	11,242
2005	642,400	642,400	20	12,848	0	59.07	0	12,848
2006	722,700	722,700	20	14,454	0	59.07	0	14,454
2007	803,000	803,000	20	16,060	0	59.07	0	16,060
2008	803,000	803,000	20	16,060	0	59.07	0	16,060
2009	3,787,240	803,000	20	16,060	2,984,240	59.07	176,279	192,339
2010	4,213,560	803,000	20	16,060	3,410,560	59.07	201,462	217,522
2011	4,639,880	803,000	20	16,060	3,836,880	59.07	226,645	242,705
2012	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2013	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2014	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2015	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2016	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2017	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2018	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2019	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2020	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2021	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2022	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2023	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2024	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2025	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2026	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2027	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2028	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2029	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2030	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2031	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2032	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887
2033	5,066,200	803,000	20	16,060	4,263,200	59.07	251,827	267,887

(Source: Statistics of SODECA and Projection by Operation Planning Staff of the JICA Study Team)

Table 7.5.5 Calculation for Miscellaneous Maintenance Costs by Alternative Master Plans

(Unit: -000- FCFA)

Alternative 1: Expansion of the Existing Water Treatment Plant

Years of Depreciation	Description of Construction	Investment Amount (A)	Amt to be Depreciated (A*0.9)	Durable Years	Rate of Depreciation	Amt of Depreciation (B)	Misc Maint. Cost (B*0.75)
2004 - 2019	Borehole + Reservoir + Distribution Pipe Construction	3,533,000	3,179,700	16	0.062	197,141	147,856
2009 - 2048	Expansion of Existing Purification Plant	14,091,000	12,681,900	40	0.025	317,048	237,786

Alterntive 2: New Intake + Purification Plant

Years of Depreciation	Description of Construction	Investment Amount (A)	Amt to be Depreciated (A*0.9)	Durable Years	Rate of Depreciation	Amt of Depreciation (B)	Misc Maint. Cost (B*0.75)
2004 - 2019	Borehole + Reservoir + Distribution Pipe Construction	3,533,000	3,179,700	16	0.062	197,141	147,856
2009 - 2048	Expansion of Existing Purification Plant	15,896,000	14,306,400	40	0.025	357,660	268,245

Table 7.5.6 Financial Internal Rate of Return (FIRR) by Alternative Master Plans

(Unit: -000- FCFA)

Year	Revenue	Alternative 1					Alternative 2				
		Construction Cost	O/M Cost	Replacement Cost	Total Financial Cost	Cash Balance	Construction Cost	O/M Cost	Replacement Cost	Total Financial Cost	Cash Balance
2000	0	0	0	0	0	0	0	0	0	0	0
2001	0	1,177,667	0	0	1,177,667	-1,177,667	1,177,667	0	0	1,177,667	-1,177,667
2002	0	1,177,667	0	0	1,177,667	-1,177,667	1,177,667	0	0	1,177,667	-1,177,667
2003	0	1,177,667	0	0	1,177,667	-1,177,667	1,177,667	0	0	1,177,667	-1,177,667
2004	146,625	0	215,870	0	215,870	-69,246	0	215,870	0	215,870	-69,246
2005	170,531	0	225,586	0	225,586	-55,055	0	225,586	0	225,586	-55,055
2006	195,417	4,697,000	235,303	0	4,932,303	-4,736,886	5,298,667	235,303	0	5,533,969	-5,338,552
2007	221,015	4,697,000	245,019	0	4,942,019	-4,721,004	5,298,667	245,019	0	5,543,686	-5,322,670
2008	224,841	4,697,000	245,019	0	4,942,019	-4,717,178	5,298,667	245,019	0	5,543,686	-5,318,845
2009	1,078,265	0	960,492	0	960,492	117,773	0	990,951	0	990,951	87,313
2010	1,219,298	0	1,028,733	0	1,028,733	190,565	0	1,059,192	0	1,059,192	160,106
2011	1,365,050	0	1,096,974	0	1,096,974	268,076	0	1,127,433	0	1,127,433	237,616
2012	1,514,423	0	1,165,215	0	1,165,215	349,208	0	1,195,674	0	1,195,674	318,749
2013	1,537,998	0	1,165,215	0	1,165,215	372,783	0	1,195,674	0	1,195,674	342,324
2014	1,561,279	0	1,165,215	0	1,165,215	396,063	0	1,195,674	0	1,195,674	365,604
2015	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2016	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2017	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2018	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2019	1,584,324	0	1,165,215	3,533,000	4,698,215	-3,113,891	0	1,195,674	3,533,000	4,728,674	-3,144,350
2020	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2021	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2022	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2023	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2024	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2025	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2026	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2027	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2028	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2029	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2030	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2031	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2032	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2033	1,584,324	0	1,165,215	0	1,165,215	419,109	0	1,195,674	0	1,195,674	388,650
2034	(N/A)	-5,725,750	(N/A)	(N/A)	-5,725,750	5,725,750	-6,402,625	(N/A)	(N/A)	-6,402,625	6,402,625
Total	39,336,902	11,898,250	29,887,729	3,533,000	45,318,979	-5,982,077	13,026,376	30,649,213	3,533,000	47,208,588	-7,871,686

Present Value under the Condition of Discount Rate at 12%:

	Alternative 1	Alternative 2
(Revenue):	4,555,438	4,555,438
(Cost):	12,202,280	13,007,743
(Net):	-7,646,842	-8,452,304
FIRR:	-1.75%	-2.13%

(2) Appraisal

Based upon all the assumption and provision mentioned above, FIRR per alternative master plan is calculated in Table 7.5.6.

The difference among those figures of alternatives (Alternative 1: -1.75%, Alternative 2: -2.13%) is simply owing to the cost of construction.

The result certainly tells that this project is not adequate for loans, either by private finance or by so-called "soft loans" of official development assistance, but for grant.

On the other hand annual figures on the table show that this project will be sustainable in terms of O&M cost coverage if the initial investment is paid for by some development assistance with high ratio of grant element and operations of water supply are properly managed. If the project is to be implemented, more precise conditions such as possibility to raise water prices should be addressed in the future to make the project sustainable.

7.5.2 Economic Appraisal

(1) Methodology

The economic aspect of the project is appreciated in the manner of Economic Internal Rate of Return (EIRR).

(a) Project Cost

Economic cost of this project is converted from the financial cost under some conditions and assumptions stated in the following.

All the cost factors are divided into two categories: domestic procurement (local cost) and procurement from abroad (foreign cost). While foreign cost is exempted from extraction of transfer payments (e.g. taxes, subsidies, etc.), local cost has to be adjusted by eliminating those factors. The transfer payments are estimated as 18% of market prices of commodities or services purchased domestically.[3]

Standard Conversion Factor (SCF), to be applied to adjust market prices of local cost to shadow prices, is computed as 95.25% (see Table 7.5.7 "Estimation of Standard

[3] Ref. IMF, *Central African Republic: Statistical Annex*, (1998), "Summary of Tax System," pp. 49 - 50.

Conversion Factor" below).[4] The formula of SCF is defined as follows:

SCF = (I+E)/(I+Ic+E-Et+Ss)

(I: Import, E: Export, Ic: Import Tariff, Et: Export Tax, Ss: Net Subsidies).

Table 7.5.7: Estimation of Standard Conversion Factor (SCF)

(Unit: FCFA bil.)

Year	Import Amount	Export Amount	Import Tariff	Export Taxes	Net Subsidies	SCF (%)
1998	102.4	188.8	17.9	4.2	0.0	95.51
1997	75.9	101.1	11.4	2.0	0.0	94.96
1996	64.2	74.5	9.9	2.6	0.0	95.00
G/T	242.5	364.4	39.2	8.8	0.0	95.25

* Figures of year 1998 and 1997 are estimates.

Source: Republique Centrafricaine, *Budget de l'Etat, Annee 1996 - 1998,*
IMF, *International Financial Statistics, January 1999* and
IMF, *Direction of Trade Statistics Quarterly, December 1998*

The following explanation is of how to calculate each cost account (see Table 7.5.9: "Economic Internal Rate of Return").

(Replacement Cost)

Replacement Cost comprises direct cost (materials and machinery imported = foreign cost) and indirect cost (administration, etc. = local cost). According to the estimate by operation planning staff of the JICA study team, indirect cost is equal to 40% of direct cost of construction.

(Personnel Expenditure)

This account is genuinely local. The condition of unskilled labor is disregarded, because since unemployment rate in CAR is unknown but easily expected to be very high, to put stress heavily upon workers' job opportunity is possibly promote exploitation of local labor force.

[4] When calculating SCF, usually trade data of last 5 years should be indicated for reference. In the case of CAR, however, only recent 3-year statistics are available with full indicators necessary for the estimation of SCF (before 1996, breakdown of "Import Tariff" and "Export Tax" accounts were not clarified).

(Construction Cost)

In the same manner of Replacement Cost, this account is also divided into direct cost (= foreign cost) and indirect cost (= local cost). Indirect cost is estimated to be 40% of direct cost.

(Chemicals / Power Expenses)

Chemicals used for purification of water are totally imported while electricity is domestically produced. In the operation plan designed by the JICA study team, the portion of power cost out of total Chemicals / Power Expenses is 29.7%.

(Miscellaneous Maintenance Cost)

Since this cost account basically comprises procurement of spare parts of water-supply facilities, all the amount is regarded as foreign cost and to be adjusted through conversion by SCF and extraction of transfer payments.

(b) Project Benefit

Since Economic Appraisal is designed for measuring the scale of benefit and cost of a specific project from a viewpoint of contribution to the nation, while Financial Appraisal is for measuring profitability of the project, various indicators can be employed as parameters of functions for estimating EIRR.

In case of water-resource development, for example, cost reduction in spending time (to carry heavy water containers from a long distance), in medical expenditure (of water-borne/related diseases), and/or gain in opportunity benefit for kids/women to be able to go to school/to be engaged in other income-generating business are frequently taken as beneficial factors for the appraisal.

In the following analysis, however, benefit of the project is calculated based upon prospective water sales amount of public faucets (kiosk) at current rate of sales, because the current rate at kiosk can be considered to include all the prospective benefits for users of newly developed water-distribution service for following reasons:

(i) according to the basic design of Master Plans, distribution is planned to be mainly via kiosk;

(ii) most responses of shallow-well users (= people who cannot depend on private connection or kiosque at present to have an access to water supply and are the main target group of the project) to the questionnaire survey, conducted by the JICA study team in January 1999, showed that one of the most critical reasons why shallow-well users do not buy water from kiosque is not the price but the distance;[5]

(iii) average amount presented by shallow-well users for responding to the question, "How much are you ready to pay for potable water supply?", (= actual "willingness to pay") is FCFA 2,429 and it is exceeding even the amount presented by current kiosque users (FCFA 2,047);[6]

(iv) when responding to the question asking what the problem of present water supply is, shallow-well users nominated "quality of water" as the second critical next to the long distance from kiosque.[7]

In other words, if once an appropriate number of kiosques are established nearby shallow-well users' communities, they are willing to buy water from kiosques and the cost to purchase includes users' benefit, such as expenditure to avoid water-borne/related diseases or cost to reduce time spent for water collection. Therefore, it is possible to let total amount of water sales (calculated under the condition if all the distribution was done by kiosques) represent aggregate benefit of users who will be benefited by the project.[8]

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[5] Ten out of 18 interviewees (shallow-well users) responded to the question, "What is the problem you have regarding to water supply?", by choosing the answer, "Too far from SODECA connection/Kiosque" (see "Result of Questionnaire Survey on Water Consumption of 51 Household").

[6] The amount of "willingness to pay" of shallow-well users reaches 5.2% of their monthly income of household, while the figure of kiosque users is 2.2% (*Ibid.*).

[7] Six out of 18 interviewees chose "Bad quality of water" (*Ibid.*).

[8] One of possible arguments on the "willingness to pay" here is whether or not the prospective sales amount of kiosks per household is far from the actual figure of "ready to pay for water supply" per household of shallow-well users interviewed at the time of the questionnaire survey in January 1999. By the responded amount, FCFA 2,429/IIII, they can afford 4,858 liters of water per month. But if the number of family members per household is assumed 10, based upon questionnaire surveys conducted in 1996 (result: 8) and 1999 (12), supplied water

The formula used for calculation of Economic Benefit of the project is as follows (see Table 7.5.9): [Net Water Supply generated only by new developed facilities / year (m^3)] (calculated at Table 2) multiplies 1,000 multiplies [Unit Sales Price at Kiosque: 0.5 FCFA / lit.] (see Table 7.5.8 shown below) divided by 1,000 = [Economic Benefit (Unit -000-FCFA)]

Table 7.5.8: Rate of Sales at Public Faucets (Kiosque) in Bangui Metropolitan Areas

(Unit: FCFA)

Sales Volume	Sales AMT
0 — 10 liters	5
11 — 20 liters	10
21 — 30 liters	15
31 — 40 liters	20
41 — 50 liters	25
51 —100 liters	50
101 —200 liters	100

Source: SODECA

(So the unit price of kiosque water is deduced: FCFA 5 ÷ 100 = 0.5 FCFA/liter.)

/member is deduced 16 liters/day (4,858/30/10) and amounts just 64% of the targeted supply volume of the project: 25 liters/day (by kiosques). Since the target volume is set for the year 2015, however, the estimated figure of purchase volume is not so bad at present. If economic growth is successfully achieved enough to absorb effects of inflation, income per household of the target group will be able to afford the estimated increasing volume of water consumption (the water-service ratio in Bimbo-2, 3, 4 and 6, where the questionnaire survey was mainly conducted, will reach 100% (Bimbo-2 & 3) or 60% (4 & 6) in 2015 (ref. Table 2)).

Table 7.5.9(1) Economic Internal Rate of Return (EIRR) of Master Plan (Alternative 1)

(Unit: -000- FCFA, unless otherwise noted)

Year	Water Supply by New Facilities (m^3)	Benefit	Replacement Cost		Personnel Expenditure	Construction Cost		Chemicals Expense	Power Expense	Misc. Maintenance	Total Cost	Cash Balance
			(Foreign)	(Local)	(Local Cost)	(Foreign)	(Local)	(Foreign Cost)	(Local Cost)	Cost (Foreign)		
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	841,190	262,805	0	0	0	1,103,995	-1,103,995
2002	0	0	0	0	0	841,190	262,805	0	0	0	1,103,995	-1,103,995
2003	0	0	0	0	0	841,190	262,805	0	0	0	1,103,995	-1,103,995
2004	562,100	281,050	0	0	44,342	0	0	7,903	2,608	147,856	202,709	78,341
2005	642,400	321,200	0	0	50,676	0	0	9,032	2,980	147,856	210,545	110,655
2006	722,700	361,350	0	0	57,011	3,355,000	1,048,169	10,161	3,353	147,856	4,621,550	-4,260,200
2007	803,000	401,500	0	0	63,345	3,355,000	1,048,169	11,290	3,725	147,856	4,629,386	-4,227,886
2008	803,000	401,500	0	0	63,345	3,355,000	1,048,169	11,290	3,725	147,856	4,629,386	-4,227,886
2009	3,787,240	1,893,620	0	0	298,760	0	0	135,214	44,617	385,642	864,234	1,029,386
2010	4,213,560	2,106,780	0	0	332,391	0	0	152,918	50,459	385,642	921,410	1,185,370
2011	4,639,880	2,319,940	0	0	366,022	0	0	170,621	56,301	385,642	978,585	1,341,355
2012	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2013	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2014	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2015	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2016	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2017	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2018	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2019	5,066,200	2,533,100	2,523,571	788,414	399,653	0	0	188,325	62,142	385,642	4,347,747	-1,814,647
2020	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2021	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2022	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2023	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2024	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2025	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2026	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2027	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2028	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2029	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2030	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2031	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2032	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2033	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	385,642	1,035,761	1,497,339
2034	(N/A)	(N/A)	0	0	(N/A)	-4,089,821	-1,277,742	(N/A)	(N/A)	(N/A)	-5,367,563	5,367,563
Total	127,630,280	63,815,140	2,523,571	788,414	10,068,249	8,498,750	2,655,179	4,651,574	1,534,899	10,380,322	41,100,959	22,714,181

Under the Condition of Discount Rate 12% Net Present Value (NPV):	**-3,713,411**
Economic Internal Rate of Return (EIRR):	**5.90%**
Benefit / Cost Ratio (B/C):	**0.67**

Table 7.5.9(2) Economic Internal Rate of Return (EIRR) of Master Plan (Alternative2)

(Unit: -000- FCFA, unless otherwise noted)

Year	Water Supply by New Facilities (m^3)	Benefit	Replacement Cost		Personnel Expenditure	Construction Cost		Chemicals Expense	Power Expense	Misc. Maintenance	Total Cost	Cash Balance
			(Foreign)	(Local)	(Local Cost)	(Foreign)	(Local)	(Foreign Cost)	(Local Cost)	Cost (Foreign)		
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	841,190	262,805	0	0	0	1,103,995	-1,103,995
2002	0	0	0	0	0	841,190	262,805	0	0	0	1,103,995	-1,103,995
2003	0	0	0	0	0	841,190	262,805	0	0	0	1,103,995	-1,103,995
2004	562,100	281,050	0	0	44,342	0	0	7,903	2,608	147,856	202,709	78,341
2005	642,400	321,200	0	0	50,676	0	0	9,032	2,980	147,856	210,545	110,655
2006	722,700	361,350	0	0	57,011	3,784,762	1,182,435	10,161	3,353	147,856	5,185,578	-4,824,228
2007	803,000	401,500	0	0	63,345	3,784,762	1,182,435	11,290	3,725	147,856	5,193,414	-4,791,914
2008	803,000	401,500	0	0	63,345	3,784,762	1,182,435	11,290	3,725	147,856	5,193,414	-4,791,914
2009	3,787,240	1,893,620	0	0	298,760	0	0	135,214	44,617	416,101	894,693	998,927
2010	4,213,560	2,106,780	0	0	332,391	0	0	152,918	50,459	416,101	951,869	1,154,911
2011	4,639,880	2,319,940	0	0	366,022	0	0	170,621	56,301	416,101	1,009,045	1,310,895
2012	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2013	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2014	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2015	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2016	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2017	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2018	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2019	5,066,200	2,533,100	2,523,571	788,414	399,653	0	0	188,325	62,142	416,101	4,378,206	-1,845,106
2020	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2021	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2022	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2023	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2024	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2025	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2026	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2027	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2028	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2029	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2030	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2031	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2032	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2033	5,066,200	2,533,100	0	0	399,653	0	0	188,325	62,142	416,101	1,066,221	1,466,879
2034	(N/A)	(N/A)	0	0	(N/A)	-4,573,304	-1,428,792	(N/A)	(N/A)	(N/A)	-6,002,095	6,002,095
Total	127,630,280	63,815,140	2,523,571	788,414	10,068,249	9,304,554	2,906,929	4,651,574	1,534,899	11,141,807	42,919,996	20,895,144

Under the Condition of Discount Rate 12% Net Present Value (NPV):	**-4,473,875**
Economic Internal Rate of Return (EIRR):	**5.08%**
Benefit / Cost Ratio (B/C):	**0.63**

(2) Appraisal

(a) Cost Benefit Analysis

Results of calculation of EIRRs are shown in Table 7.5.9 (1) and 7.5.9(2) by alternative. The EIRR of Alternative 1 and 2 is 5.90% and 5.08% with the Cost-Benefit Ratios (B/C of 0.67 and 0.63, respectively. Alternative 1 is more efficient in economic term.

These figures are not necessarily adequate for the proposed Projects in the Master Plan to be implemented only for economic development. However, the Projects contribute to Basic Human Needs (BHN) of the people in Bangui, and therefore considering other tangible and intangible socio-economic benefits that are not accounted in the analysis both alternatives can be considered justifiable.

(b) Sensitivity Analysis

Even though any condition for the appraisal trial was carefully assumed, it can not be denied that there is some possibility to have some inevitable errors, such as unreliable data used for parameters input to formulae. Therefore, for the security of judgment whether or not proceeding with future programs of the project, Sensitivity Analysis: test of project's feasibility employing more conservative assumption of cost and benefit.

As a sensitivity test for EIRR, cases of 10%- & 20%-increase of cost and 10%- & 20%-decrease of benefit are simulated. The result is summarized in Table 7.5.10 "Sensitivity Analysis of EIRR by Alternative Master Plans" shown below.

Sensitivity analysis to the cost increase of 10%, as well as decrease of 10% in economic benefits shows that the EIRRs of both pessimistic cases are less than 5%. The results may indicate that the feasibility of the Projects should be carefully studies. For example, the start the Project of Expansion of the Existing Plant should be cautiously examined, monitoring the development of water demands. In feasibility studies, especially that of the Project of Expansion of the Existing Plant, careful cost estimates would be required, searching efficient operation and maintenance as well as cheaper construction.

Table 7.5.10: Sensitivity Analysis of EIRR
by Alternative Master Plans

Alternative 1

	Cost		
Benefit	Base	+10%	+20%
Base	5.90%	4.55%	3.36%
-10%	4.41%	3.11%	1.95%
-20%	2.81%	1.55%	0.43%

Alternative 2

	Cost		
Benefit	Base	+10%	+20%
Base	5.08%	3.79%	2.65%
-10%	3.66%	2.42%	1.32%
-20%	2.13%	0.94%	-0.10%

7.5.3 Social Appraisal

(1) Methodology

The social appraisal of the project is based upon the following checklist.[9] Also the remarks for improving impact of the project are indicated.

(2) Appraisal — Social Impacts

The following Table 7.5.11 shows comprehensive effects expected from the project.

[9] The checklist is made based upon JICA, *Study of Social Analysis Guideline for Development Study Project* (1992)

Table 7.5.11: Comprehensive Social Effects of the Project

Area	Impact of the project	Remark
Employment Opportunity	During the construction period, employment opportunities will be created.	
	Operation and maintenance will create more employment	
Work Load for Water Collectors	If safe-water places are nearer, it will save the time and energy of water collector	
Sanitation and Hygiene	Availability of safe water results smaller number of water-related diseases. Therefore, the cost for health becomes less, and they will be able to use money for other purposes.	Sanitation and/or hygiene education must be encouraged to stimulate people to use safe water even though it costs more.
	Since children are the biggest number of victims of water-related diseases, safe water supply benefits children's health most.	Schools can encourage sanitation and hygiene education to children, and through children to adults.
Socio-economic Impact on Women	Since most of water collectors are women, they can save their time for other productive/ reproductive activities	It is useful if the project considers women's role in productive/ reproductive activities
Socio-economic Impact on Children	Since many children are involved in water collection presently, they can save their time for taking education more.	Water supply facilities at schools are also poor. The project had better consider the improvement.
Social Strain	Because of the shortage of water supply system, there is sometimes social tension among the neighbourhood. For example, people must buy water from their neighbours and sometimes it is overcharged or not available to sell. If sufficient public water-supply system is established, such tension will be eased.	

7.5.4 Synthetic Project Appraisal

Based upon the results of financial, economic and social analyses investigated hitherto, a comprehensive appraisal of the project can be summarized as follows:

(1) In case of Alternative plans 1 and 2, FIRR shows less than zero (Alternative 1: -1.75% & Alternative 2: -2.13%). The result indicates these projects are generally negative, in other word these are not to be financed by loans but grants.

(2) EIRR of these projects show at 5.90% and 5.08% respectively. Considering the importance of this project which cater for the basic human needs (BHN) giving direct and indirect benefits to the society and development, even though EIRRs are around 5% to 6%, the proposed Alternative plans can be considered. However, it can be said that feasibility of the project shall not be easily guaranteed. The sensitivity analysis also requires to pay more attention to budget control / proper management of the project implementation, if proceeding with the project to the next steps, in order to secure effective use of limited financial resources.

(3) In other respects, social analysis shows that the project, if once it is implemented, will be accompanied with some significant BHN impacts, especially in terms of relieving opportunity costs for children's and women's labor to attain time for education and other works, even though the effect is difficult to be quantitatively measured.

(4) In conclusion, this project is not financially self-sufficient. It is feasible, on the other hand, if (a) BHN aspects are highly evaluated from political viewpoints (of both the CAR government and grant donor(s)), and (b) organizational arrangements to monitor proper management of various procedures and financial control of the project are successfully established.

7.5.5 Conclusion

In accordance with the result of financial and economic appraisal dealt in the former chapter, there were small differences on the appraised indices between the two plans of Alternative 1 and 2. Beside of above points, it is required to appraise from the points of organization and management of the proposed system, environmental impact, and social impact in order to identify the advantageous one.

1) Organization and Management of the proposed system

The major difference between the two alternative plans is locations of new facilities such as a raw water intake plant, water treatment plant and the related apparatuses to be introduced for the water demand in 2015, which shall be recommended to construct by 2009 in the master plan study. In Alternative 1 the proposed can be constructed in the same properties of the existing facilities. In Alternative 2, however, the proposed facilities shall be erected in newly developed areas that located far from cities. Accordingly it is possible to operate those facilities by one operational team in Alternative 1. In Alternative 2, however, two operational teams have to work at the existing facilities in parallel with the proposed ones. That means Alternative 2 requires more operational staff and cost than Alternative 1. Moreover, from a security point of view, Alternative 2 is more difficult to keep the safety operation in case of emergency than Alternative 1 because of its physical isolation.

Therefore it is concluded that Alternative 1 is superior to Alternative 2 in point of management.

2) Level of Engineering Technology

The proposed water supply facilities to the both Alternatives are basically the same component with the existing ones which are presently operated by SODECA. Therefore it is not needed to introduce any new engineering technology.

Accordingly, there is no particular difference between the two Alternatives in point of engineering technology.

3) Environmental impact

There is a remarkable difference between the two alternatives. As mentioned in 1) above, in Alternative 2 the proposed facilities shall be constructed in newly reclaimed areas. Since the proposed locations for these facilities are isolated from the city, an access road with about 8km length shall be required to construct in forests and privately cultivated fields. The road shall be used for a transmission pipe route and also for the purpose of construction and maintenance of the facilities. Though there is no datum about existence of precious species of animals and plants to preserve in this area, it is indispensable to cut down and reclaim the forest and fields rather widely in Alternative 2 than in Alternative 1.

Therefore it is concluded that Alternative 1 is superior to Alternative 2 in point of environmental impact.

4) Socio-economic impact

It is justified that the project shall provide a huge benefit not only to sanitation and hygiene conditions but also to socio-economic conditions of residents especially to women and children. But in a construction stage of the project, a wider land acquisition for construction of the proposed facilities shall be needed in Alternative 2 than Alternative 1. These areas belong to the Government, however, the areas are partly used as manioc or some other vegetable cultivation fields by people who live in the vicinity. Therefore it is required to remove the fields or, if necessary, compensate these land users for taking over the fields. During construction and after completion of the project, however, the residents living in the vicinity shall be provided some advantages of employment opportunity of the construction work, an easier transportation by using the new access road etc. Accordingly particular differences are not observed between the two alternatives in point of socio-economic impact.

5) Conclusion

From the above appraisals characteristics of the two alternatives are summarized in Table 7.5.12.

Table 7.5.12. Comprehensive Appraisal

Items	Alternative Plan 1	Alternative Plan
1. Financial Appraisal FIRR	-1.75%	-2.13%
2. Economical Appraisal EIRR Benefit / Cost Ratio	5.90% 0.67	5.08% 0.63
3. Level of Engineering Technology	Even	Even
4. Organization & Management of the proposed system	Better	Good
5. Environmental impact	Better	Good
6. Socio-economic impact	Even	Even
Comprehensive Appraisal	**Better**	**Good**

In accordance with the above table, it was decided that Alternative 1 is more beneficial and effective than Alternative 2 to implement for the study area in future.

Chapter 8 Selection of Project for Feasibility Study

In accordance with the result obtained in Chapter 7.5, the alternative plans for the target year 2015 are not evaluated so positive to be implemented as the loan basis project. However, considering a steep increase of population and water demand in the Metropolitan area, a feasibility study for short ranged period should be indispensable especially for the suburban area of Bangui City.

The groundwater development project formulated as the sub-project 1 in Chapter 7.2.4 covers the area where population is highly growing under the circumstance without sufficient and sanitary water. Moreover, the people in this area are generally categorized into the lowest income group in the Metropolitan and they are also exposed to a high risk of sweep of water born diseases.

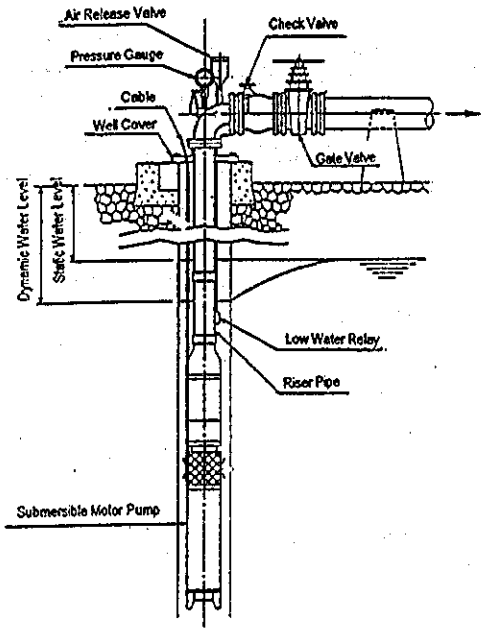
The groundwater development project has an advantage of utilizing raw water which costs cheaper to produce than the surface water which shall be treated with chemicals and energy and more manpower for purifying the raw water. An initial cost of this project is also lower than the other sub-projects whose source is the surface water.

From the BHN point of view the groundwater development project can be consequently identified as the most suitable one for feasibility study to be done the next stage.

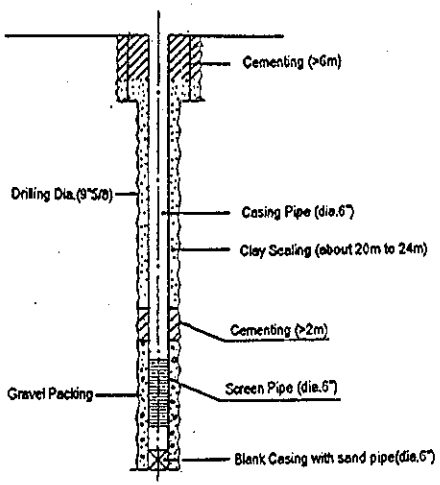
APPENDIX

1. Drawings of Master Plan Project
    - 1.1 Typical Section of Deep Well and Casing Program
    - 1.2 Deep Well Conveyance Pump Station
    - 1.3 Intake Pumping Station on Mbali River
    - 1.4 Pumping Equipment of Intake Plant
    - 1.5 Water Treatment Plant
    - 1.6 Mpoko River Crossing, Aqueduct

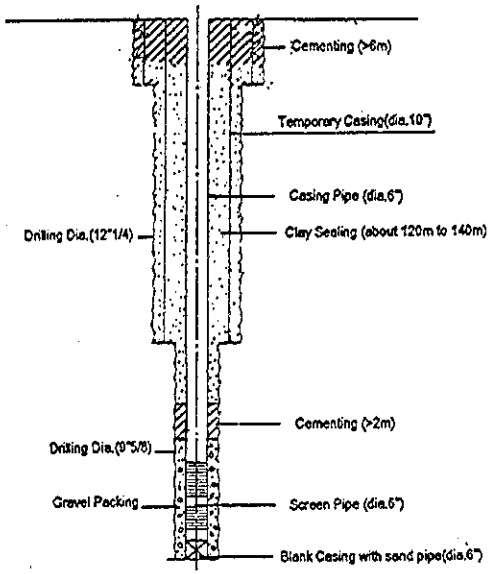
2. Break Down of Cost Estimation of the Alternative Project



Typical Section of Deepwell

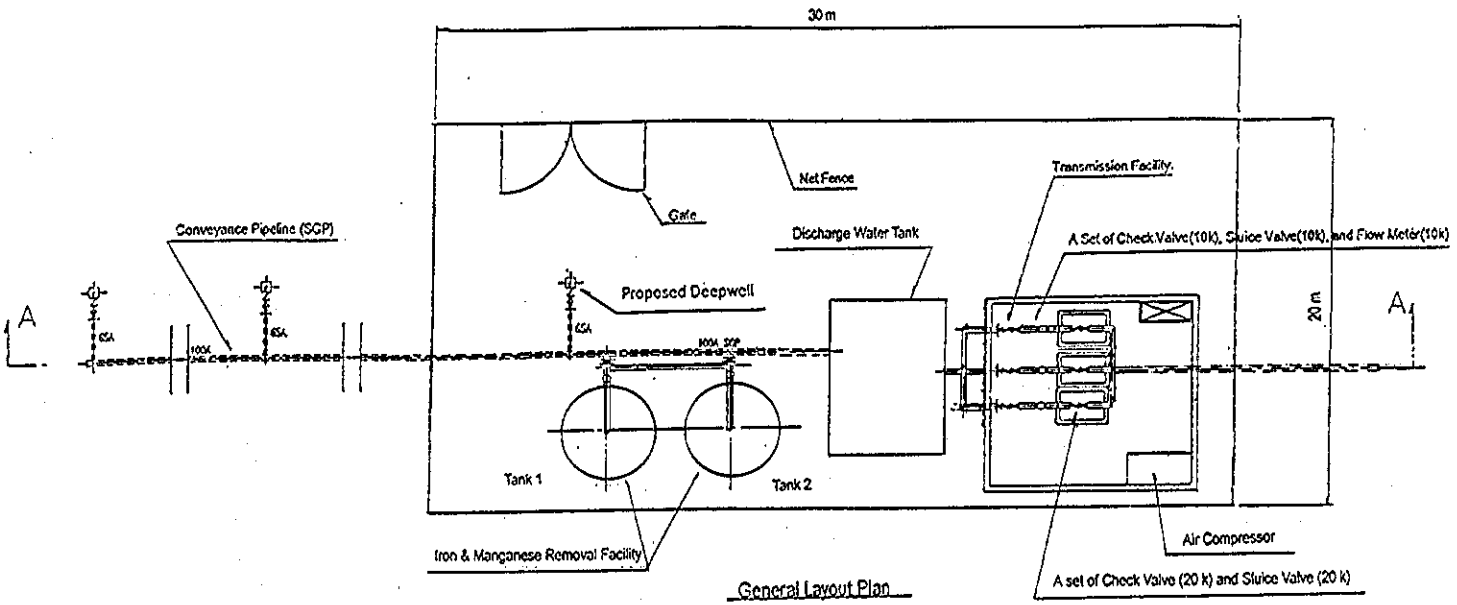


Typical Section of Drilling & Casing Program in Bakongo Area

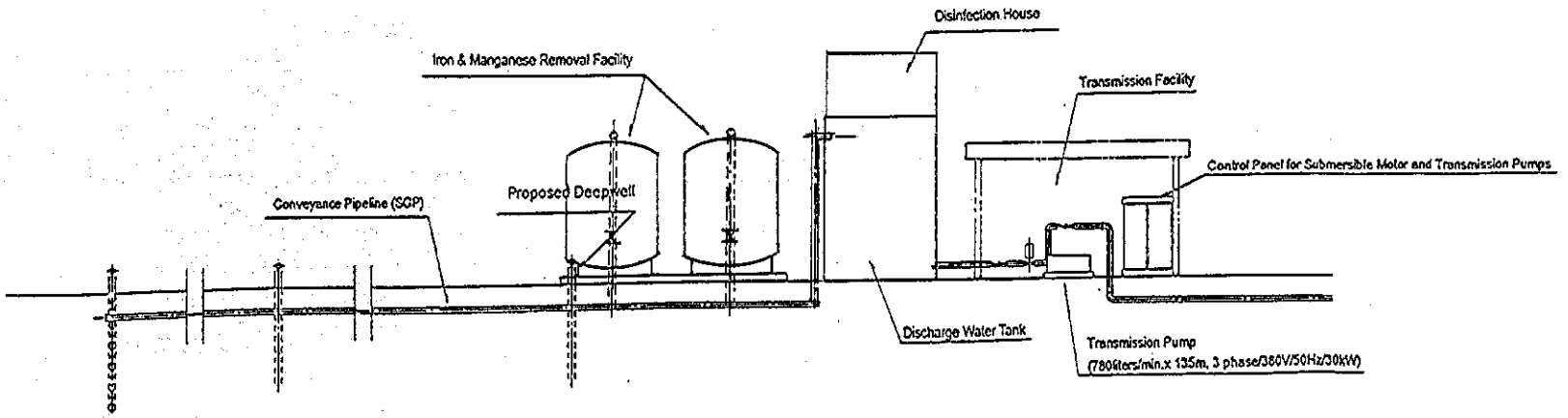


Typical Section of Drilling & Casing Program in Mbossoro Area

1.1 Typical Section of Deep Well and Casing Program

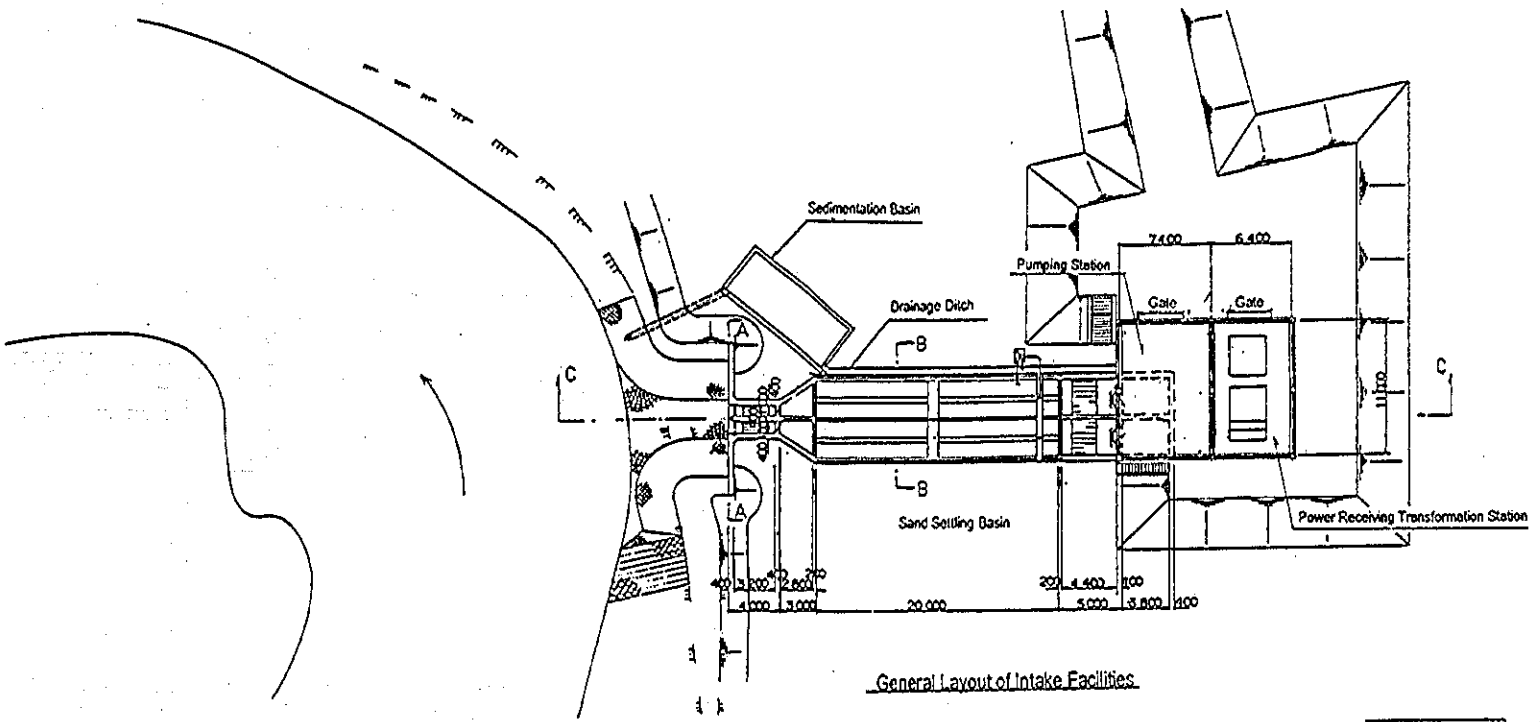


General Layout Plan

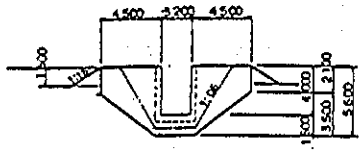


A-A Section

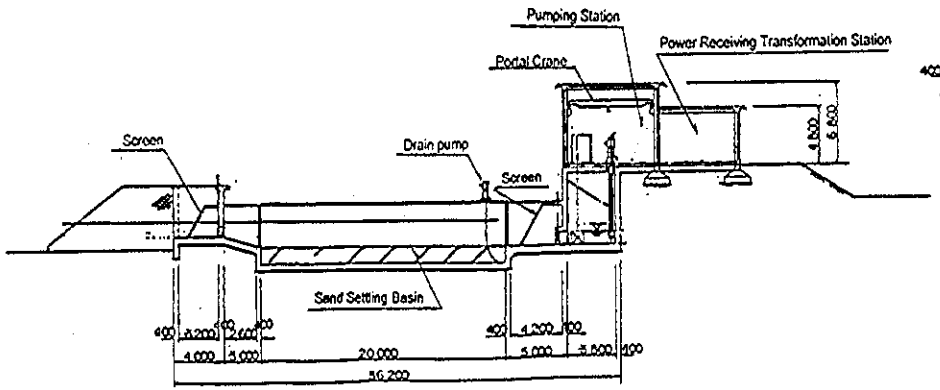
1.2 Deep Well Conveyance Pump Station



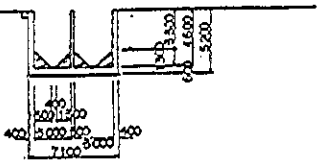
General Layout of Intake Facilities



A-A Section

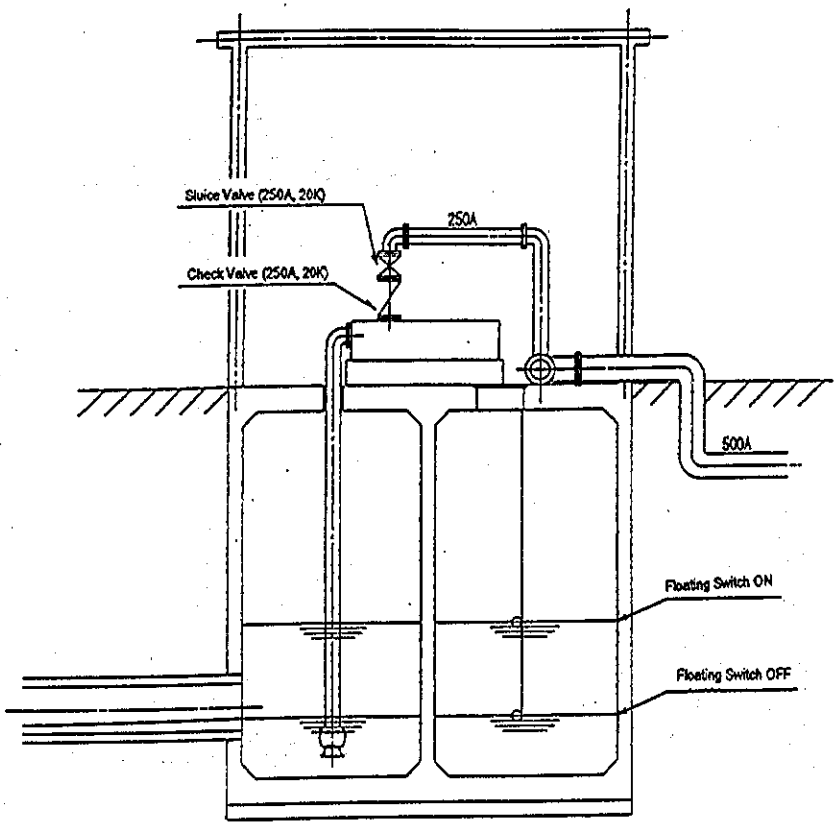


C-C Section

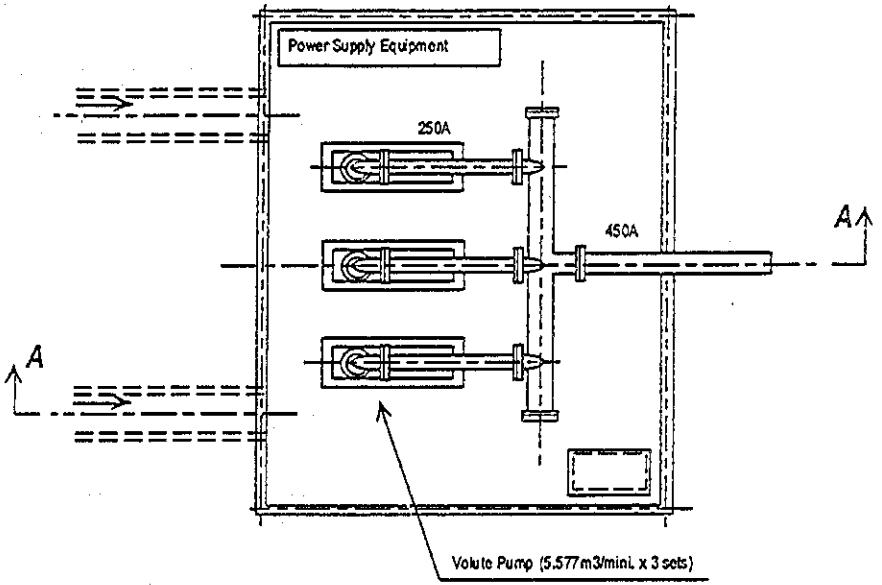


B-B Section

1.3 Intake Pumping Station on Mbali River

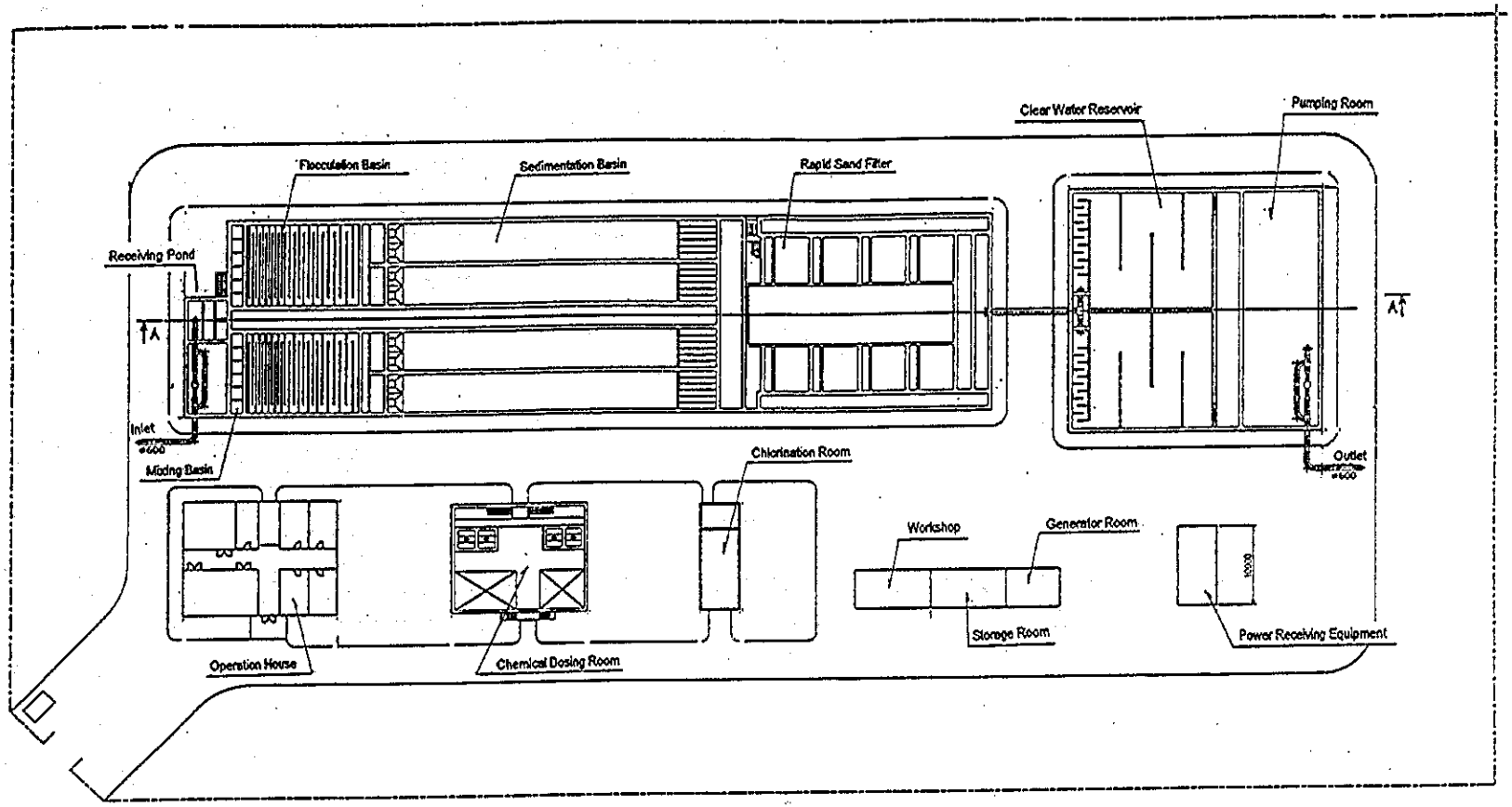


A-A Section

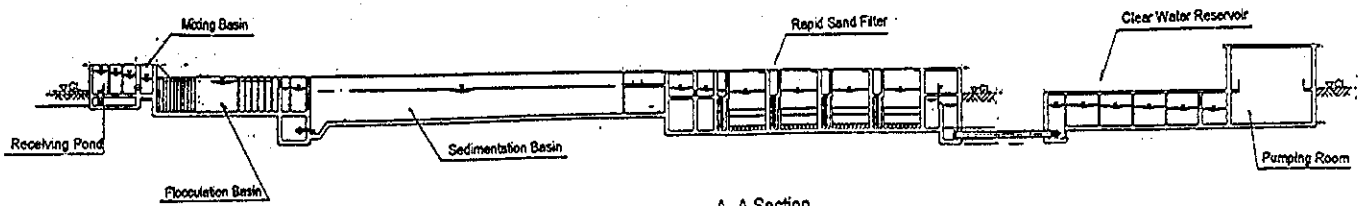


Layout Plan

1.4 Intake Facilities (layout of pump facilities)

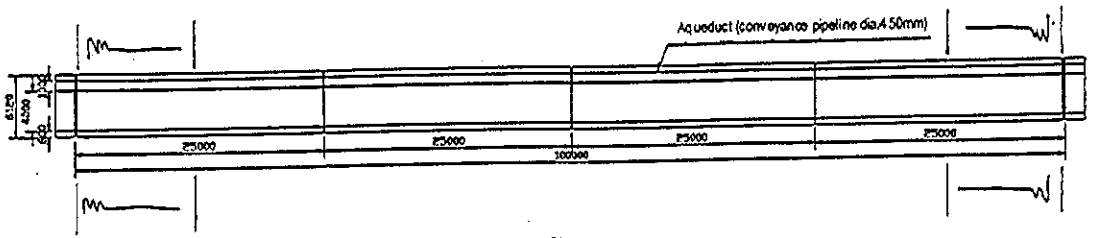


General Layout Plan

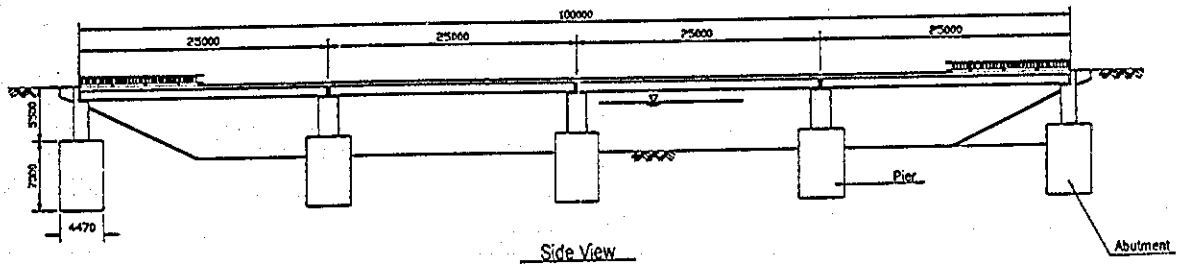


A-A Section

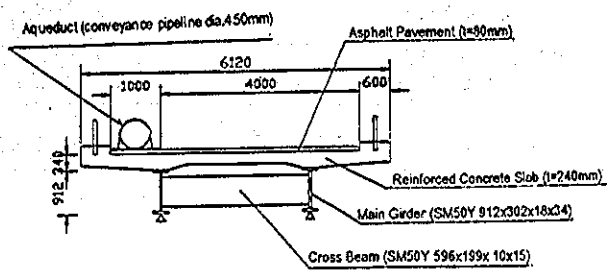
1.5 Water Treatment Plant



Plan



Side View



Typical Cross Section

1.6 Mpoko River Crossing, Aqueduct

Appendix 2. Breakdown of Cost Estmation of Alternative Plans

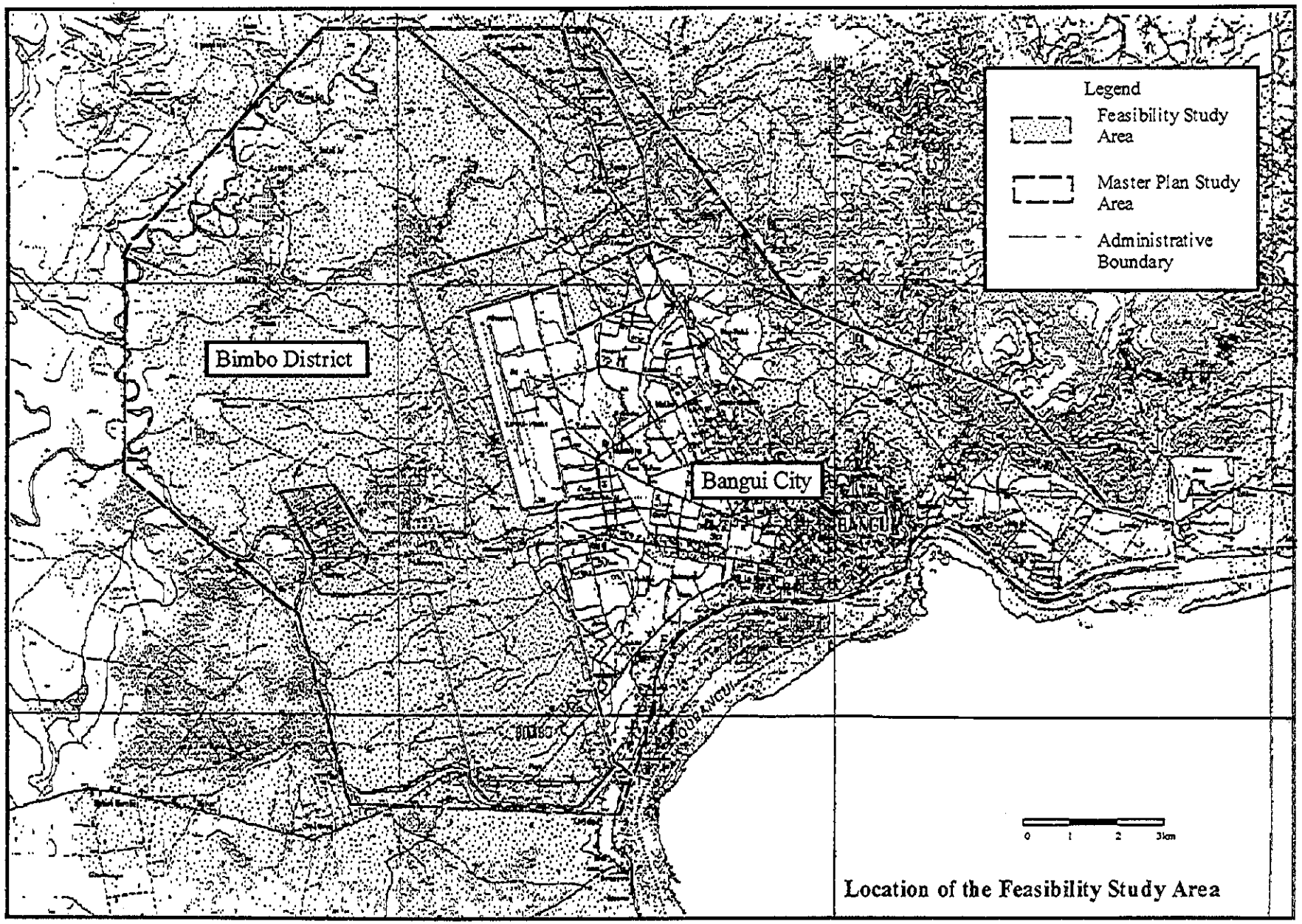
Items	Specifications	Unit	Qant.	Unit Price (100FCFR)	Cost (100FCFR)	Remarks
1. Project for target year of 2005 (F/S)						
(1) Intake Facilities						
Deep well	Casing Dia. 6Åh, Well Depth 150m	nos	3	28,500.00	85,500.0	Drilling、Casing、Screen
Deep well	Casing Dia. 6Åh, Well Depth 50m	nos	3	9,500.00	28,500.0	Drilling、Casing、Screen
Submergible Pump	4.32 lit'sec'unit、T.Head 30m、3.7kw	nos	6	11,500.00	69,000.0	Suction pipe、Fittings、Control panel
Sterilization facility		nos	6	2,200.00	13,200.0	Chlorine injection equipment
Operation House		nos	6	5,400.00	32,400.0	12m2
Fence、Drainage etc.		set	6	10,000.00	60,000.0	
Electric transmission line		set	6	1,500.00	9,000.0	3phase,380V,50H z
Suction Tank	Ve= 6m3、W2x L3x H2	nos	2	2,460.00	4,920.0	1 tank／3 wells、pump house
Transmission Pump	12.96 lit'sec、T.Head135m、30kw	nos	4	22,000.00	88,000.0	2 pomp/tank、electric motor、control panel
Electric transmission line		set	2	2,800.00	5,600.0	3phase、380V、50H z
Sub Total					396,120.0	
(2) Conveyance Pipeline of Raw Water (From Deepwell to Binbo Reservoir)						
Ductile Pipe	Dia. 200mm	m	4,600	50.50	232,300.0	including gate valve, air valve, drainage valve, etc.
ditto	Dia.150mm	m	2,800	38.50	107,800.0	ditto
Construction of O&M Road	Width 5m	m	1,100	57.50	63,250.0	
Sub Total					403,350.0	
(3) Reservoir on the hill						
Reservoir	Ve=1900 m3、W25 x L25 x H3.5	set	1	256,500.00	256,500.0	
Operator's house		set	1	5,400.00	5,400.0	12m2
Appurtenant Work	Fencing work, Drainage facility, etc.	lot	1	200.00	200.0	
Sub Total					262,100.0	
(4) Distribution Main						
PVC Pipe	Dia 300mm	m	12,700	58.00	736,600.0	including gate valve, air valve, drainage valve, etc.
ditto	Dia.125mm	m	3,600	11.00	39,600.0	ditto
ditto	Dia.100mm	m	3,400	8.50	28,900.0	ditto
ditto	Dia.80mm	m	5,200	7.50	39,000.0	ditto
ditto	Dia.50mm	m	5,200	3.00	15,600.0	ditto
Sub Total			30,100		859,700.0	
(5) Secondary Distribution						
D-VIII(1)	30.9人/ha	Km2	3.20	26,572.50	85,032.0	PVC pipe
B-1	8.6人/ha	Km2	3.50	15,240.00	53,340.0	
B-2	9.6人/ha	Km2	2.10	16,010.00	33,621.0	
B-3	5.2人/ha	Km2	3.40	12,630.00	42,942.0	
B-4	2.8人/ha	Km2	6.30	10,790.00	67,977.0	
B-5	1.8人/ha	Km2	5.00	10,020.00	50,100.0	
B-6	1.3人/ha	Km2	11.40	9,640.00	109,896.0	
B-7	0.7人/ha	Km2	9.00	9,175.00	82,575.0	
Elevated Tank	H=20m	nos	2	33,500.00	67,000.0	Land clearance, Collecting chamber, boosting pump, Tank, Pipes, Fencing、Operator's house
Sub Total					592,483.0	
Total Direct Cost					2,513,753.0	
Indirect Cost					1,005,501.2	40% of Direct Cost
Grand Total					3,519,254.2	

2. Expansion of Existing Treatment Plant 14,100 m³/day						
(1) Intake Pumping Station						
Installation of an additional pump	dia 300mm、T.head55m、11m3/min、190kw	lot	1	64,765.50	64,765.5	including electric motor,receiving panel, control panel
(2) Expansion of Exisiting Plant						
Expansion of Exisiting Plant	design treatment capacity 14100×1.1 = 15,500 m³/day	lot	1	3,630,000.00	3,630,000.0	including electric and contrl houses, drainage fencing work, etc.
(3) Transmission Facilities						
Installation of boosting pumps	59.81liters/sec, T.head 143m,140kW	unit	2	51,565.50	103,131.0	including one standby
Boosting Pump House		lot	1	40,300.00	40,300.0	
Transmission pipeline	dia 300mm, DCIP	m	11,500	79.50	914,250.0	
Sub Total					1,057,681.0	
(4) Service Reservoir						
Reservoir 1	capacity 5,500 m³/unit	unit	1	742,500.00	742,500.0	
Reservoir 2	capacity 1,900 m³/unit	unit	1	256,500.00	256,500.0	
Sub Total					999,000.0	
(5) Distribution main (Area1, Area 2, Area3)						
DCIP 350mm		m	800	92.50	74,000.0	including gate valve, air valve, drainage valve, etc.
PVC 300mm		m	2,800	58.00	162,400.0	ditto
PVC 250mm		m	3,300	40.50	133,650.0	ditto
PVC 200mm		m	14,600	26.50	386,900.0	ditto
PVC 150mm		m	5,700	16.50	94,050.0	ditto
PVC 100mm		m	8,600	8.50	73,100.0	ditto
PVC 65mm		m	11,200	5.50	61,600.0	ditto
PVC 50mm		m	17,400	3.00	52,200.0	ditto
Sub Total			64,400		1,037,900.0	
(6) Secondary distribution						
D-I	14.2persons/ha	Km2	5.46	19,538.50	106,680.2	PVC
D-II	54.6persons/ha	Km2	5.47	50,545.50	276,483.9	PVC
D-III	25.2persons/ha	Km2	5.10	27,981.00	142,703.1	PVC
D-IV	51.5persons/ha	Km2	5.51	48,166.50	265,397.4	PVC
D-V	27.4persons/ha	Km2	6.40	29,669.50	189,884.8	PVC
D-VI	58.3persons/ha	Km2	6.69	53,385.50	357,149.0	PVC
D-VII	32.3persons/ha	Km2	7.76	33,430.50	259,420.7	PVC
D-VIII(1)	50.7persons/ha	Km2	3.20	47,552.50	152,168.0	PVC
D-VIII(2)	89.1persons/ha	Km2	3.02	77,024.50	232,614.0	PVC
B-1	22.9persons/ha	Km2	3.50	26,216.00	91,756.0	PVC
B-2	25.5persons/ha	Km2	2.10	28,211.50	59,244.2	PVC
B-3	13.8persons/ha	Km2	3.40	19,231.50	65,387.1	PVC
B-4	7.8persons/ha	Km2	6.30	14,626.50	92,147.0	PVC
B-5	4.9persons/ha	Km2	5.00	12,401.00	62,005.0	PVC
B-6	3.6persons/ha	Km2	11.40	11,403.00	129,994.2	PVC
B-7	1.8persons/ha	Km2	9.00	10,021.50	90,193.5	PVC
B-8	0.9persons/ha	Km2	12.60	9,330.00	117,558.0	PVC
B-9	1.0persons/ha	Km2	33.40	9,410.00	314,294.0	PVC
B-10	1.6persons/ha	Km2	20.60	9,870.00	203,322.0	PVC
Elevated tank	H=20m	unit	2	33,500.00	67,000.0	Land clearance, Collecting chamber, boosting pump, Tank, Pipes, Fencing、Operator's house
Sub Total					3,275,402.0	

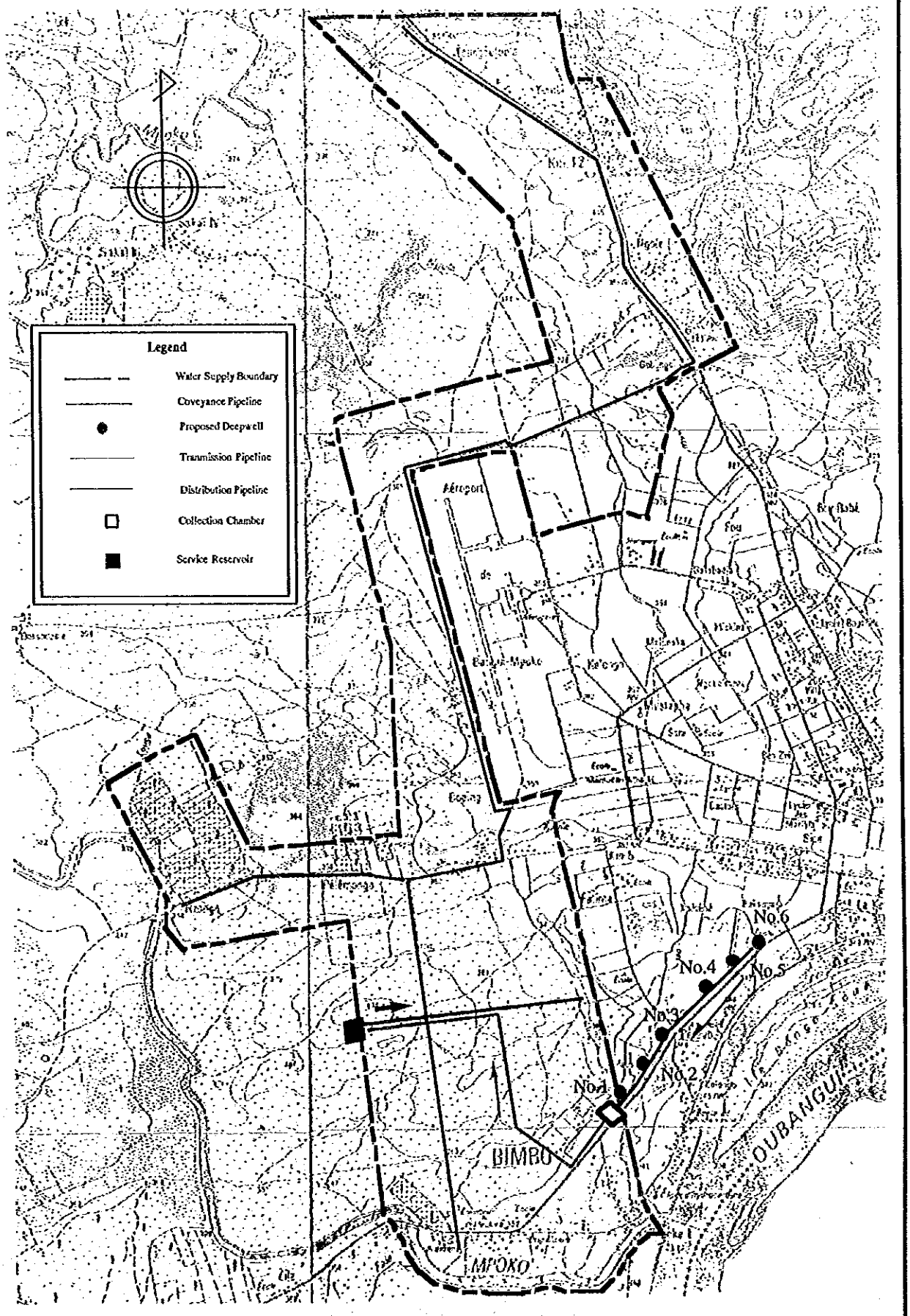
Total Direct Cost					10,061,748.5	
Indirect Cost					4,025,899.4	40% of Direct Cost
Grand Total					14,090,647.9	
3. New Treatment Plant 14,100 m3/day						
(1) Intake Facilities						
Intake Facility		ot	1	108,500.00	108,500.0	including intake gte, sluiceway, revetment, suction chamber
Intake pump	dia 250 mm、5.38m³/min、head152m、230kw、	unit	3	75,365.50	226,096.5	including one standby, electric motr, receiving panel, control panel
Pump House		unit	1	40,300.00	40,300.0	14 x 8 = 112
Fencing work and drainage work		lot	1	10,000.00	10,000.0	
Wiring work from power transmision line		lot	1	90,000.00	90,000.0	3 phase,380V,50H z
Earth work		lot	1	162,000.00	162,000.0	300 x 300 x 2m = 180,000m3
Sub Total					636,896.5	
(2) Raw Water Transmission						
DCIP dia 450mm		m	11,400	135.00	1,539,000.0	including gate valve, air valve, drainage valve, etc
River crossing work	bridge length100 m, width 5 m	lot	1	305,000.00	305,000.0	
Sub Total					1,844,000.0	
(3) New Treatment Plant on the BIMBO hill						
Treatment plant	design treatment capacity 15,500 m³/day	lot	1	4,025,000.00	4,025,000.0	Including electro-mechanic equipment, control house, earth work, drainage facility, fencing work, etc.
Wiring work		lot	1	40,000.00	40,000.0	3 phases, 380V, 50H z
Sub Total					4,065,000.0	
(4) Service Reservoir	Capacity 1,900 m³/unit	unit	1	256,500.00	256,500.0	
(5) Distribution Main						
same as alternative 1		m	64,400		1,037,900.0	
Tranmission pipeline		m	3,000	79.50	238,500.0	
					1,276,400.0	
(6) Secodary Distribution	same as Alternative 1				3,275,402.0	
Total Direct Cost					11,354,198.5	
Indirect Cost					4,541,679.4	40% of Direct Cost
Grand Total					15,895,877.9	

FEASIBILITY STUDY

REPORT



Location of the Feasibility Study Area



Layout Plan of Water Supply Facilities

THE STUDY
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