Table C.4.1 Results of Water Balance Analysis under Future Conditions

(Unit: '000 m^3)

Block Name	Gross Area (ha)	Annual Average Water Resources			Annual Average Water Demand				Deficit	Surplus	Annual Probable Deficit*		
		Runoff	Dam/Lake	Total	Irrigation	Livestock	Municipal	Total			1st (1/20)	2nd (1/10)	4th (1/5)
1. Suta	1,277	11,414	4,904	16,318	8,641	36	0	8,677	88	7,728	712	453	218
		9	4	13	7	0	0	7	0	6	1	0	0
2. Cap-1**	1,365	38,737	912	39,649	9,237	38	3,156	12,431	37	27,254	581	115	0
		28	1	29	7	0	2	9	0	20	0	0	0
3. Cucunuba	1,892	4,463	7,330	11,793	9,218	53	0	9,271	6	2,528	120	0	0
		2	4	6	5	0	0	5	0	1	0	0	0
4. Lenguazaque	2,309	39,572	0	39,572	14,062	65	0	14,127	2,673	28,118	5,252	4,997	4,610
		17	0	17	6	0	0	6	1	12	2	2	2
5. Cap-2	1,582	35,419	3,087	38,506	10,705	45	0	10,750	97	27,853	1,059	411	62
		22	2	24	7	0	0	7	0	18	1	0	0
6. Mariño	700	70,958	0	70,958	4,263	20	0	4,283	1,403	68,078	2,445	2,444	2,216
		101	0	101	6	0	0	6	2	97	3	3	3
7. Mariño-Ubate	387	68,789	0	68,789	2,357	11	0	2,368	950	67,372	1,425	1,441	1,364
		178	0	178	6	0	0	6	2	174	4	4	4
8. Fuquene	2,537	17,815	9,484	27,299	15,451	71	0	15,522	0	11,776	0	0	0
		7	4	11	6	0	0	6	0	5	0	0	0
9. Honda	509	17,525	1,185	18,710	3,100	14	0	3,114	0	15,597	0	0	0
		34	2	37	6	0	0	6	0	31	0	0	0
10. Susa	563	10,309	1,481	11,790	2,678	16	0	2,694	0	9,096	0	0	0
		18	3	21	5	0	0	5	0	16	0	0	0
11. Suarez***	8,309	261,430	13,405	274,835	30,320	146	6,312	36,778	0	238,058	0	0	0
		31	2	33	4	0	1	4	0	29	0	0	0
12. Simijaca	417	24,392	0	24,392	1,998	9	0	2,007	121	22,505	1,164	420	168
		58	0	58	5	0	0	5	0	54	3	1	0
13. Old-Suarez	228	272,033	0	272,033	982	6	0	988	0	271,045	0	0	0
		1,193	0	1,193	4	0	0	4	0	1,189	0	0	0
14. Madron	1,359	11,907	0	11,907	5,854	38	0	5,892	2,896	8,910	4,721	4,638	4,522
		9	0	9	4	0	0	4	2	7	3	3	3
15. Merchan	640	294,458	100	294,558	2,757	18	0	2,775	0	291,782	0	0	0
		460	0	460	4	0	0	4	0	456	0	0	0
16. Honda. Extension	349	17,705	0	17,705	2,125	10	0	2,135	207	15,777	969	470	321
		51	0	51	6	0	0	6	1	45	3	1	1
17. Susa. Extension	426	11,500	0	11,500	2,026	12	0	2,038	351	9,813	1,070	926	588
		27	0	27	5	0	0	5	1	23	3	2	1
Total	24,849	--	41,888	--	125,774	608	9,468	135,850	8,829	--	--	--	--

Note) * 1st, 2nd and 4th annual deficit values in 20 years (in descending order) correspond to 20, 10 and 5 years probable values, respectively.

** Municipal: Ubate, *** Municipal: Chiquinquira. 1. Figures in lower row mean per ha values.

Table C.4.2 Hato Dam Water Supply under Future Conditions

	Necessary Release Water from Hato Dam ('000 m^3/month)*																			Return Period ('000 m^3)**		
Mon.	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	1/20	1/10	1/5
Jan.	2,175	4,372	1,290	2,669	2,073	4,591	3,877	2,561	3,672	4,248	3,642	3,907	1,452	2,882	3,466	2,500	2,361	1,755	1,880	424	4,591	4,372	3,907
Feb.	949	2,653	374	1,169	755	3,049	2,221	2,213	1,619	2,586	2,016	1,953	749	1,499	2,148	1,145	1,090	953	1,571	1,186	3,049	2,653	2,221
Mar.	746	846	621	866	439	2,045	1,332	992	440	1,651	1,693	351	502	191	1,337	440	530	178	291	901	2,045	1,693	1,337
Apr.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	175	4	0	4	0	0	0	7	45	0	0	0	71	0	0	0	117	0	175	117	45
Jun.	0	6	9	66	142	28	53	0	0	0	0	0	70	7	227	0	53	0	91	9	227	142	70
Jul.	788	872	822	955	1,270	2,590	2,548	1,230	462	398	588	417	1,271	737	2,281	906	630	788	798	467	2,590	2,548	1,271
Aug.	1,672	837	912	958	1,004	2,820	2,897	1,923	520	1,313	1,365	2,093	1,702	755	2,480	997	1,033	492	891	654	2,897	2,820	2,093
Sep.	577	390	472	409	691	1,228	1,098	202	271	518	0	1,349	574	280	851	304	392	248	324	312	1,349	1,228	851
Dec.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Nov.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Dec.	892	708	760	700	1,599	379	1,120	378	1,825	866	414	2,177	653	508	638	750	760	115	315	3,041	3,041	2,177	1,599

Note) * Including irrigation, livestock and Ubate municipal water use. These figures are derived from water balance analysis.

** 1st, 2nd and 4th values in 20 years (in descending order) correspond to 20,10 and 5 years probable values.

Table C.4.3 Results of Optimization Simulation of Fuquene Lake (Future Conditions: Case-1)

Case		Rainy Season Operation Water Level (El. m)																		
		2539.5			2539.3			2539.1			2538.9			2538.7			2538.5			2538.3		
Dry Season Operation Water Level (El. m)	2539.5	MAX	1/2	39.84	MAX	1/2	39.76	MAX	1/2	39.70	MAX	1/2	39.66	MAX	1/2	39.65	MAX	1/2	39.65			
			1/5	40.05		1/5	39.99		1/5	39.94		1/5	39.92		1/5	39.91		1/5	39.91			
			1/10	40.19		1/10	40.14		1/10	40.09		1/10	40.09		1/10	40.09		1/10	40.08			
			1/20	40.32		1/20	40.29		1/20	40.24		1/20	40.25		1/20	40.26		1/20	40.24			
		MIN	1/2	39.07	MIN	1/2	39.01	MIN	1/2	38.85	MIN	1/2	38.72	MIN	1/2	38.63	MIN	1/2	38.59			
			1/5	38.87		1/5	38.79		1/5	38.62		1/5	38.49		1/5	38.40		1/5	38.33			
			1/10	38.79		1/10	38.70		1/10	38.52		1/10	38.39		1/10	38.30		1/10	38.22			
			1/20	38.73		1/20	38.64		1/20	38.44		1/20	38.32		1/20	38.22		1/20	38.14			
		MODE	39.4-39.5	31.3	MODE	39.3-39.4	28.3	MODE	39.1-39.2	19.4	MODE	39.3-39.4	17.2	MODE	39.4-39.5	14.9	MODE	39.3-39.4	14.9			
		CAV.		1.0	CAV.		1.5	CAV.		5.7	CAV.		7.4	CAV.		9.3	CAV.		9.7			
	2539.3				MAX	1/2	39.68	MAX	1/2	39.63	MAX	1/2	39.59	MAX	1/2	39.57	MAX	1/2	39.57	MAX	1/2	39.56
						1/5	39.93		1/5	39.89		1/5	39.86		1/5	39.85		1/5	39.84		1/5	39.84
						1/10	40.10		1/10	40.06		1/10	40.03		1/10	40.03		1/10	40.03		1/10	40.03
						1/20	40.26		1/20	40.23		1/20	40.20		1/20	40.21		1/20	40.20		1/20	40.21
					MIN	1/2	38.87	MIN	1/2	38.79	MIN	1/2	38.68	MIN	1/2	38.59	MIN	1/2	38.54	MIN	1/2	38.53
						1/5	38.69		1/5	38.58		1/5	38.46		1/5	38.37		1/5	38.30		1/5	38.28
						1/10	38.62		1/10	38.48		1/10	38.36		1/10	38.27		1/10	38.19		1/10	38.17
						1/20	38.56		1/20	38.42		1/20	38.29		1/20	38.20		1/20	38.12		1/20	38.09
					MODE	39.2-39.3	30.4	MODE	39.1-39.2	25.9	MODE	39.2-39.3	21.7	MODE	39.2-39.3	20.4	MODE	39.2-39.3	19.6	MODE	39.2-39.3	19.9
					CAV.		1.8	CAV.		6.3	CAV.		7.8	CAV.		9.6	CAV.		10.2	CAV.		10.5
	2539.1							MAX	1/2	39.55	MAX	1/2	39.49	MAX	1/2	39.48	MAX	1/2	39.47	MAX	1/2	39.46
									1/5	39.83		1/5	39.79		1/5	39.77		1/5	39.77		1/5	39.77
									1/10	40.02		1/10	39.98		1/10	39.97		1/10	39.97		1/10	39.97
									1/20	40.19		1/20	40.17		1/20	40.15		1/20	40.16		1/20	40.16
								MIN	1/2	38.63	MIN	1/2	38.58	MIN	1/2	38.51	MIN	1/2	38.46	MIN	1/2	38.43
									1/5	38.45		1/5	38.39		1/5	38.31		1/5	38.25		1/5	38.21
									1/10	38.37		1/10	38.31		1/10	38.22		1/10	38.16		1/10	38.12
									1/20	38.31		1/20	38.25		1/20	38.16		1/20	38.10		1/20	38.05
								MODE	39.0-39.1	26.7	MODE	39.0-39.1	24.5	MODE	39.0-39.1	22.9	MODE	39.0-39.1	22.2	MODE	39.0-39.1	22.1
								CAV.		9.7	CAV.		10.6	CAV.		13.0	CAV.		13.4	CAV.		13.5
	2538.9										MAX	1/2	39.46	MAX	1/2	39.42	MAX	1/2	39.41	MAX	1/2	39.40
												1/5	39.75		1/5	39.73		1/5	39.72		1/5	39.72
												1/10	39.95		1/10	39.93		1/10	39.92		1/10	39.93
												1/20	40.13		1/20	40.12		1/20	40.12		1/20	40.13
											MIN	1/2	38.44	MIN	1/2	38.41	MIN	1/2	38.38	MIN	1/2	38.36
												1/5	38.26		1/5	38.22		1/5	38.18		1/5	38.14
												1/10	38.18		1/10	38.15		1/10	38.10		1/10	38.05
												1/20	38.13		1/20	38.09		1/20	38.03		1/20	37.99
											MODE	38.8-38.9	20.2	MODE	38.8-38.9	20.6	MODE	38.8-38.9	20.2	MODE	38.8-38.9	19.7
											CAV.		21.2	CAV.		23.5	CAV.		22.9	CAV.		22.8

Note) MAX: Probable Annual Maximum Water Level. MIN: Probable Annual Minimum Water Level. MODE: Mode of Water Level Distribution (%).

CAV.: Rate of Cavitation Period at Chiquinquira Pumping Station (%).

: MAX (1/2) is less than 39.5. : Optimum Operation Rule.

Table C.4.4 Results of Optimization Simulation of Fuquene Lake (Future Conditions: Case-2)

Case		Rainy Season Operation Water Level (El. m)																			
		2539.5			2539.3			2539.1			2538.9			2538.7			2538.5				
Dry Season Operation Water Level (El. m)	2539.5	MAX	1/2	39.79	MAX	1/2	39.69	MAX	1/2	39.65	MAX	1/2	39.61								
			1/5	39.97		1/5	39.88		1/5	39.84		1/5	39.82								
			1/10	40.09		1/10	40.00		1/10	39.96		1/10	39.96								
			1/20	40.20		1/20	40.11		1/20	40.08		1/20	40.09								
		MIN	1/2	39.07	MIN	1/2	38.98	MIN	1/2	38.82	MIN	1/2	38.65								
			1/5	38.87		1/5	38.78		1/5	38.59		1/5	38.41								
			1/10	38.78		1/10	38.69		1/10	38.50		1/10	38.31								
			1/20	38.72		1/20	38.63		1/20	38.43		1/20	38.24								
		MODE	39.4-39.5	30.5	MODE	39.3-39.4	28.2	MODE	39.1-39.2	22.8	MODE	39.3-39.4	14.8								
		CAV.		1.0	CAV.		1.2	CAV.		5.5	CAV.		8.7								
	2539.3				MAX	1/2	39.63	MAX	1/2	39.56	MAX	1/2	39.51	MAX	1/2	39.49					
						1/5	39.84		1/5	39.79		1/5	39.73		1/5	39.72					
						1/10	39.99		1/10	39.93		1/10	39.88		1/10	39.87					
						1/20	40.12		1/20	40.08		1/20	40.02		1/20	40.02					
					MIN	1/2	38.85	MIN	1/2	38.78	MIN	1/2	38.62	MIN	1/2	38.50					
						1/5	38.66		1/5	38.57		1/5	38.39		1/5	38.28					
						1/10	38.58		1/10	38.48		1/10	38.30		1/10	38.18					
						1/20	38.52		1/20	38.42		1/20	38.23		1/20	38.11					
					MODE	39.2-39.3	30.2	MODE	39.1-39.2	27.6	MODE	39.2-39.3	18.8	MODE	39.2-39.3	16.5					
					CAV.		2.7	CAV.		6.0	CAV.		9.3	CAV		12.2					
	2539.1							MAX	1/2	39.47	MAX	1/2	39.41	MAX	1/2	39.41	MAX	1/2	39.40		
									1/5	39.73		1/5	39.67		1/5	39.67		1/5	39.66		
									1/10	39.89		1/10	39.84		1/10	39.84		1/10	39.83		
									1/20	40.05		1/20	40.00		1/20	40.00		1/20	40.00		
								MIN	1/2	38.61	MIN	1/2	38.56	MIN	1/2	38.46	MIN	1/2	38.38		
									1/5	38.44		1/5	38.36		1/5	38.25		1/5	38.17		
									1/10	38.36		1/10	38.28		1/10	38.16		1/10	38.09		
									1/20	38.31		1/20	38.22		1/20	38.10		1/20	38.02		
								MODE	39.0-39.1	29.7	MODE	39.0-39.1	26.5	MODE	39.0-39.1	23.4	MODE	39.0-39.1	22.4		
								CAV		9.6	CAV.		10.9	CAV		14.5	CAV.		14.5		

Note) MAX: Probable Annual Maximum Water Level. MIN: Probable Annual Minimum Water Level. MODE: Mode of Water Level Distribution (%).

CAV.: Rate of Cavitation Period at Chiquinquira Pumping Station (%).

: MAX (1/2) is less than 39.5. : Optimum Operation Rule.

Table C.4.5 Results of Optimization Simulation of Fuquene Lake (Future Conditions: Case-3)

Case		Rainy Season Operation Water Level (El. m)																					
		2539.5			2539.3			2539.1			2538.9			2538.7			2538.5					
Dry Season Operation Water Level (El. m)	2539.5	MAX	1/2	39.77	MAX	1/2	39.68	MAX	1/2	39.63	MAX	1/2	39.58									
			1/5	39.94		1/5	39.85		1/5	39.80		1/5	39.78									
			1/10	40.06		1/10	39.96		1/10	39.91		1/10	39.91									
			1/20	40.17		1/20	40.07		1/20	40.02		1/20	40.04									
		MIN	1/2	39.05	MIN	1/2	38.98	MIN	1/2	38.79	MIN	1/2	38.62									
			1/5	38.84		1/5	38.76		1/5	38.56		1/5	38.40									
			1/10	38.76		1/10	38.67		1/10	38.45		1/10	38.31									
			1/20	38.69		1/20	38.60		1/20	38.38		1/20	38.24									
		MODE	39.4-39.5	30.9	MODE	39.3-39.4	30.0	MODE	39.1-39.2	21.6	MODE	38.9-39.0	13.9									
		CAV.		1.0	CAV.		2.1	CAV.		6.6	CAV.		9.1									
	2539.3				MAX	1/2	39.61	MAX	1/2	39.54	MAX	1/2	39.49	MAX	1/2	39.45						
						1/5	39.81		1/5	39.75		1/5	39.70		1/5	39.68						
						1/10	39.94		1/10	39.89		1/10	39.83		1/10	39.83						
						1/20	40.06		1/20	40.02		1/20	39.96		1/20	39.98						
					MIN	1/2	38.84	MIN	1/2	38.77	MIN	1/2	38.60	MIN	1/2	38.46						
						1/5	38.65		1/5	38.55		1/5	38.38		1/5	38.25						
						1/10	38.57		1/10	38.46		1/10	38.29		1/10	38.15						
						1/20	38.52		1/20	38.39		1/20	38.22		1/20	38.08						
					MODE	39.2-39.3	31.1	MODE	39.1-39.2	30.4	MODE	39.2-39.3	19.3	MODE	39.1-39.2	15.8						
					CAV.		3.4	CAV.		6.3	CAV.		9.2	CAV.		14.9						
	2539.1							MAX	1/2	39.45	MAX	1/2	39.37	MAX	1/2	39.36	MAX	1/2	39.34			
									1/5	39.69		1/5	39.62		1/5	39.60		1/5	39.58			
									1/10	39.84		1/10	39.78		1/10	39.76		1/10	39.75			
									1/20	39.99		1/20	39.93		1/20	39.91		1/20	39.90			
								MIN	1/2	38.60	MIN	1/2	38.52	MIN	1/2	38.42	MIN	1/2	38.29			
									1/5	38.42		1/5	38.32		1/5	38.20		1/5	38.06			
									1/10	38.35		1/10	38.24		1/10	38.11		1/10	37.96			
									1/20	38.29		1/20	38.18		1/20	38.05		1/20	37.89			
								MODE	39.0-39.1	31.0	MODE	39.0-39.1	23.6	MODE	39.0-39.1	21.6	MODE	39.0-39.1	20.4		
								CAV.		10.6	CAV.		13.1	CAV.		17.5	CAV.		19.7			

Note) MAX: Probable Annual Maximum Water Level. MIN: Probable Annual Minimum Water Level. MODE: Mode of Water Level Distribution (%).

CAV.: Rate of Cavitation Period at Chiquinquira Pumping Station (%).

: MAX (1/2) is less than 39.5. : Optimum Operation Rule.

Table C.4.6 Results of Optimization Simulation of Fuquene Lake (Future Conditions: Case-4)

Case		Rainy Season Operation Water Level (El. m)																					
		2539.5			2539.3			2539.1			2538.9			2538.7			2538.5					
Dry Season Operation Water Level (El. m)	2539.5	MAX	1/2	39.75	MAX	1/2	39.66	MAX	1/2	39.59	MAX	1/2	39.55									
			1/5	39.91		1/5	39.81		1/5	39.75		1/5	39.74									
			1/10	40.01		1/10	39.90		1/10	39.85		1/10	39.87									
			1/20	40.11		1/20	40.00		1/20	39.95		1/20	39.99									
		MIN	1/2	39.05	MIN	1/2	38.98	MIN	1/2	38.81	MIN	1/2	38.60									
			1/5	38.85		1/5	38.76		1/5	38.58		1/5	38.38									
			1/10	38.76		1/10	38.67		1/10	38.49		1/10	38.29									
			1/20	38.70		1/20	38.60		1/20	38.42		1/20	38.22									
		MODE	39.4-39.5	31.3	MODE	39.3-39.4	32.50	MODE	39.1-39.2	22.9	MODE	38.9-39.0	14.6									
		CAV.		1.0	CAV.		2.10	CAV.		5.7	CAV.		9.7									
	2539.3				MAX	1/2	39.59	MAX	1/2	39.50	MAX	1/2	39.46	MAX	1/2	39.41						
						1/5	39.76		1/5	39.70		1/5	39.66		1/5	39.62						
						1/10	39.88		1/10	39.82		1/10	39.79		1/10	39.76						
						1/20	39.99		1/20	39.95		1/20	39.91		1/20	39.90						
					MIN	1/2	38.84	MIN	1/2	38.74	MIN	1/2	38.59	MIN	1/2	38.42						
						1/5	38.65		1/5	38.54		1/5	38.38		1/5	38.18						
						1/10	38.57		1/10	38.45		1/10	38.29		1/10	38.08						
						1/20	38.51		1/20	38.39		1/20	38.22		1/20	38.00						
					MODE	39.2-39.3	31.2	MODE	39.1-39.2	29.4	MODE	39.2-39.3	17.9	MODE	39.1-39.2	17.2						
					CAV.		3.3	CAV.		6.6	CAV.		9.8	CAV.		16.0						
	2539.1							MAX	1/2	39.42	MAX	1/2	39.34	MAX	1/2	39.31	MAX	1/2	39.28			
									1/5	39.63		1/5	39.55		1/5	39.52		1/5	39.52			
									1/10	39.76		1/10	39.68		1/10	39.66		1/10	39.68			
									1/20	39.90		1/20	39.81		1/20	39.79		1/20	39.83			
								MIN	1/2	38.59	MIN	1/2	38.51	MIN	1/2	38.40	MIN	1/2	38.25			
									1/5	38.40		1/5	38.30		1/5	38.17		1/5	38.00			
									1/10	38.32		1/10	38.21		1/10	38.07		1/10	37.89			
									1/20	38.26		1/20	38.15		1/20	38.00		1/20	37.81			
								MODE	39.0-39.1	30.2	MODE	38.9-39.0	23.4	MODE	39.0-39.1	20.9	MODE	39.0-39.1	18.6			
								CAV.		11.0	CAV.		13.2	CAV.		18.1	CAV.		23.3			

Note) MAX: Probable Annual Maximum Water Level. MIN: Probable Annual Minimum Water Level. MODE: Mode of Water Level Distribution (%).

CAV.: Rate of Cavitation Period at Chiquinquira Pumping Station (%).

: MAX (1/2) is less than 39.5. : Optimum Operation Rule.

Table C.5.1 Cost Estimate of Irrigation System Improvement (1/4)

Improvement Block	Item	Work Quantity Amount	Unit	Unit Price ('000 Pesos)	Amount (Million Pesos)	('000 US$)
1. Suta. Present	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-ST1)	1	L.S.		276	
	(2) Gate (G-ST2)	1	L.S.		276	
	Sub-total (Intake works)				552	
	1.2 Ditch works					
	(1) Ditch	9,500	m	8.8	84	
	(2) Ditch structures	1	L.S.		90	
	Sub-total (Ditch works)				174	
	Sub-total (Direct construction cost)				726	378
	2. Land acquisition and compensation				150	
	3. Engineering and administration costs (20 % of 1+2)				175	
	4. Physical contingency (10 % of 1+2)				88	
	5. Total				1,139	593
2. Suta. Extension	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-ST3)	1	L.S.		276	
	Sub-total (Intake works)				276	
	1.2 Ditch works					
	(1) Ditch	1,000	m	8.8	9	
	(2) Ditch structures	1	L.S.		33	
	Sub-total (Ditch works)				42	
	Sub-total (Direct construction cost)				318	166
	2. Land acquisition and compensation				16	
	3. Engineering and administration costs (20 % of 1+2)				67	
	4. Physical contingency (10 % of 1+2)				33	
	5. Total				434	226
3. Cap-1. Present	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	Sub-total (Intake works)				0	
	1.2 Ditch works					
	(1) Ditch	15,700	m	26.3	413	
	(2) Ditch structures	1	L.S.		105	
	Sub-total (Ditch works)				518	
	Sub-total (Direct construction cost)				518	270
	2. Land acquisition and compensation				247	
	3. Engineering and administration costs (20 % of 1+2)				153	
	4. Physical contingency (10 % of 1+2)				77	
	5. Total				995	518
4. Cap-1. Extension	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	Sub-total (Intake works)				0	
	1.2 Ditch works					
	(1) Ditch	12,300	m	10.0	123	
	(2) Ditch structures	1	L.S.		135	
	Sub-total (Ditch works)				258	
	Sub-total (Direct construction cost)				258	134
	2. Land acquisition and compensation				194	
	3. Engineering and administration costs (20 % of 1+2)				90	
	4. Physical contingency (10 % of 1+2)				45	
	5. Total				587	306

Note) Exchange Rate: 1US$ = 1,920 Colombian Pesos (1999 October). I.V.A is not included.

Table C.5.1 Cost Estimate of Irrigation System Improvement (2/4)

Improvement Block	Item	Work Quantity Amount	Unit	Unit Price ('000 Pesos)	Amount (Million Pesos)	('000 US$)
5. Lenguazaque. Extension	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-LG1)	1	L.S.		435	
	(2) Gate (G-LG2)	1	L.S.		435	
	(3) Gate (G-LG3)	1	L.S.		553	
	Sub-total (Intake works)				1,423	
	1.2 Ditch works					
	(1) Ditch	21,400	m	8.8	188	
	(2) Ditch structures	1	L.S.		156	
	Sub-total (Ditch works)				344	
	Sub-total (Direct construction cost)				1,767	920
	2. Land acquisition and compensation				337	
	3. Engineering and administration costs (20 % of 1+2)				421	
	4. Physical contingency (10 % of 1+2)				210	
	5. Total				2,735	1,424
6. Cap-2. Present	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	Sub-total (Intake works)				0	
	1.2 Ditch works					
	(1) Ditch	31,800	m	17.5	557	
	(2) Ditch structures	1	L.S.		374	
	Sub-total (Ditch works)				931	
	Sub-total (Direct construction cost)				931	485
	2. Land acquisition and compensation				501	
	3. Engineering and administration costs (20 % of 1+2)				286	
	4. Physical contingency (10 % of 1+2)				143	
	5. Total				1,861	969
7. Mariño. Present	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-MA1)	1	L.S.		218	
	(2) Turnout (T-MA1)	1	L.S.		18	
	Sub-total (Intake works)				236	
	1.2 Ditch works					
	(1) Ditch	7,600	m	8.8	67	
	(2) Ditch structures	1	L.S.		78	
	Sub-total (Ditch works)				145	
	Sub-total (Direct construction cost)				381	198
	2. Land acquisition and compensation				120	
	3. Engineering and administration costs (20 % of 1+2)				100	
	4. Physical contingency (10 % of 1+2)				50	
	5. Total				651	339
8. Honda. Extension	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-HO1)	1	L.S.		435	
	Sub-total (Intake works)				435	
	1.2 Ditch works					
	(1) Ditch	9,100	m	8.8	80	
	(2) Ditch structures	1	L.S.		132	
	Sub-total (Ditch works)				212	
	Sub-total (Direct construction cost)				647	337
	2. Land acquisition and compensation				143	
	3. Engineering and administration costs (20 % of 1+2)				158	
	4. Physical contingency (10 % of 1+2)				79	
	5. Total				1,027	535

Note) Exchange Rate: 1US$ = 1,920 Colombian Pesos (1999 October). I.V.A is not included.

Table C.5.1 Cost Estimate of Irrigation System Improvement (3/4)

Improvement Block	Item	Work Quantity Amount	Unit	Unit Price ('000 Pesos)	Amount (Million Pesos)	('000 US$)
9. Susa. Present	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-SS1)	1	L.S.		218	
	(2) Pump (P-SS1)	1	L.S.		94	
	Sub-total (Intake works)				312	
	1.2 Ditch works					
	(1) Ditch	11,900	m	8.8	105	
	(2) Ditch structures	1	L.S.		108	
	Sub-total (Ditch works)				213	
	Sub-total (Direct construction cost)				525	273
	2. Land acquisition and compensation				187	
	3. Engineering and administration costs (20 % of 1+2)				142	
	4. Physical contingency (10 % of 1+2)				71	
	5. Total				925	482
10. Susa. Extension	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-SS2)	1	L.S.		218	
	(2) Gate (G-SS3)	1	L.S.		218	
	Sub-total (Intake works)				436	
	1.2 Ditch works					
	(1) Ditch	8,900	m	8.8	78	
	(2) Ditch structures	1	L.S.		114	
	Sub-total (Ditch works)				192	
	Sub-total (Direct construction cost)				628	327
	2. Land acquisition and compensation				140	
	3. Engineering and administration costs (20 % of 1+2)				154	
	4. Physical contingency (10 % of 1+2)				77	
	5. Total				999	520
11. Simijaca. Extensio	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-SI1)	1	L.S.		276	
	(2) Gate (G-SI2)	1	L.S.		276	
	Sub-total (Intake works)				552	
	1.2 Ditch works					
	(1) Ditch	9,000	m	8.8	79	
	(2) Ditch structures	1	L.S.		83	
	Sub-total (Ditch works)				162	
	Sub-total (Direct construction cost)				714	372
	2. Land acquisition and compensation				142	
	3. Engineering and administration costs (20 % of 1+2)				171	
	4. Physical contingency (10 % of 1+2)				86	
	5. Total				1,113	580
12. Old-Suarez. Presen	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Turnout (T-OS1)	1	L.S.		18	
	Sub-total (Intake works)				18	
	1.2 Ditch works					
	(1) Ditch	6,200	m	8.8	55	
	(2) Ditch structures	1	L.S.		54	
	Sub-total (Ditch works)				109	
	Sub-total (Direct construction cost)				127	66
	2. Land acquisition and compensation				98	
	3. Engineering and administration costs (20 % of 1+2)				45	
	4. Physical contingency (10 % of 1+2)				23	
	5. Total				293	153

Note) Exchange Rate: 1US$ = 1,920 Colombian Pesos (1999 October). I.V.A is not included.

Table C.5.1 Cost Estimate of Irrigation System Improvement (4/4)

Improvement Block	Item	Work Quantity Amount	Unit	Unit Price ('000 Pesos)	Amount (Million Pesos)	('000 US$)
13. Merchan. Present	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	Sub-total (Intake works)				0	
	1.2 Ditch works					
	(1) Ditch	1,000	m	8.8	9	
	(2) Ditch structures	1	L.S.		33	
	Sub-total (Ditch works)				42	
	Sub-total (Direct construction cost)				42	22
	2. Land acquisition and compensation				16	
	3. Engineering and administration costs (20 % of 1+2)				12	
	4. Physical contingency (10 % of 1+2)				6	
	5. Total				76	40
14. Merchan. Extensio	1. Direct construction cost (including A.I.U)					
	1.1 Intake works					
	(1) Gate (G-ME1)	1	L.S.		1,450	
	Sub-total (Intake works)				1,450	
	1.2 Ditch works					
	(1) Ditch	6,600	m	8.8	58	
	(2) Ditch structures	1	L.S.		91	
	Sub-total (Ditch works)				149	
	Sub-total (Direct construction cost)				1,599	833
	2. Land acquisition and compensation				104	
	3. Engineering and administration costs (20 % of 1+2)				341	
	4. Physical contingency (10 % of 1+2)				170	
	5. Total				2,214	1,153

Note) Exchange Rate: 1US$ = 1,920 Colombian Pesos (1999 October). I.V.A is not included.

Table C.5.2 Implementation Program of Irrigation and Drainage System Improvement

(Unit: million Pesos)

Item	D/D	Phase I				Phase II				Total
	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Detailed Design Stage										
Construction Stage										
Irrigation										
1. Suta. Present			876							876
2. Suta. Extension				334						334
3. Cap-1. Present		765								765
4. Cap-1. Extension			452							452
6. Cap-2. Present				550	882					1,432
5. Lenguazaque. Extension								825	1,279	2,104
7. Mariño. Present								501		501
8. Honda. Extension									790	790
9. Susa. Present							712			712
10. Susa. Extension								768		768
11. Simijaca. Extension						856				856
12. Old-Suarez. Present							225			225
13. Merchan. Present							58			58
14. Merchan. Extension						900	803			1,703
Drainage										
Suarez River Improvement	Start									
Optimum Operation Rule										
a. Hato Dam	Start	Presnt Conditions		Increase of Water Supply		Start	Future Conditions			
b. Fuquene Lake	Start									

(Investment Cost)	(2002)	(2003)	(2004)	(2005)	(2006)	(2007)	(2008)	(2009)	(2010)	(Total)
1. Direct C/C + Land A.	0	765	1,328	884	882	1,756	1,798	2,094	2,069	11,576
2. Engin. and Admi. Cost	2,035	35	35	35	35	35	35	35	35	2,315
3. Physical Contingency	0	77	133	88	88	176	180	209	207	1,158
4. Total	2,035	877	1,496	1,007	1,005	1,967	2,013	2,338	2,311	15,049
(O&M Cost)	(2002)	(2003)	(2004)	(2005)	(2006)	(2007)	(2008)	(2009)	(2010)	(2011-)
1. Irrigation	0	0	0	95.4	124.7	163.7	184.6	256.1	293.1	348.6
2. Drainage	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5

Note) Figures under bar chart mean Direct Construction Cost and Land Acquisition.

Table C.6.1 National Criteria of Portable Water in Colombia

Parameter	Unit	Value	Parameter	Unit	Value
Color	UPC	<15	NO_3	mg/l	10
Odor or Flavor		Acceptable	Ag	mg/l	0.01
Turbidity	UNT	<5	Pb	mg/l	0.01
Total Solids	mg/l	<500	Se	mg/l	0.01
Conductivity	μ mhos/l	50-1,000	ABS	mg/l	0.5
Floating Substance	mg/l	Absent	T-Trihalomethane	mg/l	0.1
Al	mg/l	0.2	Grease & Oil	mg/l	absent
Sb	mg/l	0.005	Ca	mg/l	60
As	mg/l	0.01	$CaCO_3$ (Acidity)	mg/l	50
Ba	mg/l	0.5	$CaCO_3$ (Hydroxyl)	mg/l	<LD
B	mg/l	0.3	$CaCO_3$ (T-Alkalinity)	mg/l	100
Cd	mg/l	0.003	Cl^-	mg/l	250
CN^-(Free and Dissolved)	mg/l	0.05	$CaCO_3$ (T-Hardness)	mg/l	160
Total CN^-	mg/l	0.1	Total Fe	mg/l	0.30
$CHCl_3$	mg/l	0.03	Mg	mg/l	36
Cu	mg/l	1.0	Mn	mg/l	0.10
Cr^{6+}	mg/l	0.01	SO_4^{2-}	mg/l	250
Total Phenol	mg/l	0.001	Zn	mg/l	5
Hg	mg/l	0.001	F^-	mg/l	1.20
Mo	mg/l	0.07	PO_4^{3-}	mg/l	0.20
Ni	mg/l	0.02	pH	mg/l	6.5-9.0
NO_2	mg/l	0.1	Cl_2 Residue	mg/l	0.2-1.0

Table C.6.2 Results of Water Quality Analysis at Intake Point in Suarez River

Parameter	Unit	Rainy Season				Dry Season		
		1999.4.16	1999.5.13	1999.5.14	Average	1999.7.14	1999.7.27	Average
Discharge	m^3/s	4.0	4.2	5.1	4.4	-	-	-
Water Temperature	℃	17.4	14.0	16.8	16.1	17.1	19.3	18.2
Color		Light Yellow	Light Yellow	Light Brown	-	14.0	120.0	67.0
Odor		Odorless	Odorless	Odorless	-	-	-	-
EC	mS/S	33.6	180.0	180.0	131.2	304.0	362.0	333.0
Turbidity		117.3	34.0	34.0	61.8	55.0	27.0	41.0
pH		7.0	6.9	6.9	6.9	6.7	6.7	6.7
Disslolved Oxygen	mg/l	0.3	-	-	0.3	1.4	3.2	2.3
BOD	mg/l	1.0	2.0	-	1.5	2.0	2.6	2.3
COD	mg/l	62.0	62.0	31.0	51.7	51.8	30.3	41.1
TOC	mg/l	-	-	-	-	5.6	-	5.6
Humic Acid	mg/l	-	-	-	-	11.1	-	11.1
T-N	mg/l	2.9	2.0	-	2.4	2.2	2.8	2.5
NH_4-N	mg/l	1.2	-	-	1.2	0.3	0.7	0.5
NO_3-N	mg/l	0.3	-	-	0.3	0.1	0.4	0.3
NO_2-N	mg/l	ND	-	-	-	ND	0.0	0.0
T-P	mg/l	0.2	0.1	0.1	0.1	0.0	0.1	0.1
PO_4-P	mg/l	0.0	-	-	0.0	0.0	0.0	0.0
SS	mg/l	83.0	26.0	35.0	48.0	28.6	10.0	19.3
Volatile SS	mg/l	32.0	3.0	18.0	17.7	27.1	0.0	13.6
Phenols	mg/l	ND	-	-	-	ND	-	-
As	mg/l	ND	-	-	-	ND	-	-
Cd	mg/l	ND	-	-	-	ND	-	-
CN^-	mg/l	ND	-	-	-	ND	-	-
Cr^{6+}	mg/l	ND	-	-	-	ND	-	-
Cu	mg/l	ND	-	-	-	ND	-	-
Hg	mg/l	ND	-	-	-	ND	-	-
Ni^{2+}	mg/l	ND	-	-	-	ND	-	-
Pb	mg/l	ND	-	-	-	ND	-	-
Zn	mg/l	ND	-	-	-	ND	-	-
Fe	mg/l	18.3	-	-	18.3	8.7	3.1	5.9
Mn	mg/l	0.3	-	-	0.3	0.3	-	0.3
Coliforms(Total)	mg/l	15×10^2	-	-	15×10^2	30×10^2	3.8×10^2	17×10^2
Coliform (Fecal)	mg/l	9×10^2	-	-	9×10^2	30×10^2	2.0×10^2	16×10^2

Table C.6.3 Water Intake Quantity and Chemical Consumption at Chiquinquira Purification Plant in September, 1999

Date	Q		$Al_2(S0_4)_3$		CaO		Cl_2	
	l/sec	m^3/day	mg/l	Kg	mg/l	Kg	mg/l	Kg
1	147.0	12,672	63.1	800.0	5.9	75.0	3.1	39.1
2	138.0	11,448	67.7	775.0	6.6	75.0	3.4	39.1
3	141.0	11,664	68.6	800.0	6.4	75.0	3.4	39.1
4	155.0	13,392	59.7	800.0	5.6	75.0	2.9	39.1
5	170.0	13,464	66.8	900.0	5.6	75.0	2.9	39.1
6	147.0	12,672	59.2	750.0	5.9	75.0	3.1	39.1
7	155.0	13,392	59.7	800.0	5.6	75.0	2.9	39.1
8	150.0	12,960	61.7	800.0	5.8	75.0	3.0	39.1
9	150.0	12,960	61.7	800.0	5.8	75.0	3.0	39.1
10	150.0	12,960	65.6	850.0	5.8	75.0	3.0	39.1
11	155.0	13,392	64.2	860.0	5.6	75.0	2.9	39.1
12	153.0	13,176	65.3	860.0	5.7	75.0	3.0	39.1
13	153.0	13,176	60.7	800.0	5.7	75.0	3.0	39.1
14	150.0	12,960	66.4	860.0	5.8	75.0	3.0	39.1
15	140.0	12,096	70.3	850.0	6.2	75.0	3.2	39.1
16	150.0	12,960	65.6	850.0	5.8	75.0	3.0	39.1
17	142.0	12,240	65.4	800.0	6.1	75.0	3.2	39.1
18	160.0	13,824	57.9	800.0	5.4	75.0	2.8	39.1
19	152.0	13,107	57.2	750.0	5.7	75.0	3.0	39.1
20	150.0	12,960	61.7	800.0	5.8	75.0	3.0	39.1
21	135.0	11,684	59.9	700.0	6.4	75.0	3.3	39.1
22	153.0	13,176	56.9	750.0	5.7	75.0	3.0	39.1
23	153.0	13,176	49.3	650.0	5.7	75.0	3.0	39.1
24	140.0	12,096	57.9	700.0	6.2	75.0	3.2	39.1
25	150.0	12,960	54.0	700.0	5.8	75.0	3.0	39.1
26	150.0	12,960	50.2	650.0	5.8	75.0	3.0	39.1
27	153.0	13,176	56.9	749.7	5.7	75.0	3.0	39.1
28	156.0	11,232	57.9	650.3	6.7	75.0	3.5	39.1
29	150.0	12,960	57.9	750.0	5.8	75.0	3.0	39.1
30	143.0	12,312	73.1	900.0	6.1	75.0	3.2	39.1
	149.7	12,774	61.4	783.5	5.9	75.0	3.1	39.1

Table C.6.4 Results of Water Quality Analysis at Chiquinquira Purification Plant in September, 1999

Date	Turbidity			NO_2		pH			Fe		Hardness		SO_3		Cl^-		Cl_2 resudue	
	In	Sed.	Out	In	Out	In	Sed.	Out	In	Out	In	Out	In	Out	In	Out	In	Out
1	161	22	9	0.1015	0.0316	6.5	5.3	5.3	9.14	0.34	11.16	3.61	94	61	17.6	7.8	1.77	0.3
2	144	23	10	0.1042	0.0319	6.5	5.3	5.3	8.86	0.31	12.65	3.55	90	53	17.4	9.0	1.84	0.4
3	138	25	10	0.1085	0.0366	6.4	5.2	5.2	8.44	0.21	14.18	3.49	88	49	17.6	8.3	1.95	0.4
4	110	28	10	0.1092	0.0384	6.4	5.0	5.0	8.62	0.31	16.19	3.33	90	45	17.5	8.5	2.00	0.3
5	100	30	10	0.1112	0.0390	6.4	5.0	5.0	8.11	0.31	17.64	3.12	73	44	17.5	8.7	2.00	0.4
6	62	36	13	0.1155	0.0462	6.4	4.9	4.9	8.94	0.32	19.98	2.71	54	42	17.8	9.7	2.04	0.4
7	88	45	14	0.1161	0.0484	6.3	5.0	5.0	9.76	0.36	19.90	2.82	71	50	17.7	9.6	2.12	0.3
8	94	48	8	0.1160	0.0436	6.3	5.1	5.2	9.88	0.34	18.71	2.90	68	52	17.9	9.1	1.93	0.3
9	167	12	6	0.1163	0.0381	5.8	5.0	5.0	11.87	0.30	17.94	2.95	76	76	17.4	8.3	2.55	0.3
10	161	10	6	0.1275	0.0313	5.8	5.0	5.0	11.22	0.36	13.61	2.38	79	60	19.6	8.9	2.31	0.4
11	174	10	6	0.1280	0.0224	5.9	5.0	4.9	10.71	0.37	9.22	2.11	84	54	24.1	9.7	1.96	0.4
12	186	9	9	0.1287	0.0132	6	5.0	4.8	10.88	0.47	6.56	1.68	100	61	23.9	9.2	1.88	0.3
13	191	10	10	0.1291	0.0146	5.8	5.0	4.7	10.91	0.39	7.45	2.19	122	66	25.7	9.4	1.90	0.2
14	212	16	7	0.1234	0.0201	5.7	5.1	5.0	17.32	0.37	6.74	2.40	120	67	24.6	9.1	1.78	0.3
15	231	16	8	0.1241	0.0232	5.6	4.9	4.0	14.30	0.42	7.28	2.21	112	66	27.8	9.3	1.92	0.4
16	242	14	6	0.1229	0.0204	5.4	4.8	4.3	9.68	0.47	6.41	1.85	98	64	24.3	9.1	2.15	0.5
17	210	12	6	0.1234	0.0213	6.1	5.7	5.0	9.61	0.43	7.40	2.34	94	62	20.1	8.8	1.99	0.3
18	89	4	6	0.0967	0.0231	6.4	5.7	5.6	3.07	0.41	8.02	7.73	40	49	16.1	9.4	1.41	0.3
19	85	4	4	0.0971	0.0230	6.4	5.6	5.6	3.23	0.40	8.10	7.45	45	47	17.0	8.6	1.69	0.4
20	86	4	6	0.0962	0.0227	6.4	5.6	5.6	3.15	0.39	8.06	7.62	42	48	18.6	9.6	1.48	0.4
21	62	5	5	0.0968	0.0336	6.4	6.1	6.0	3.30	0.34	7.20	6.50	42	47	12.9	15.8	2.10	0.3
22	47	2	3	0.0932	0.0314	6.4	5.9	5.8	2.68	0.25	7.10	7.01	31	51	18.0	11.0	1.79	0.3
23	48	3	3	0.0926	0.0321	6.3	6.0	5.9	2.84	0.30	9.28	8.35	40	48	17.3	12.3	1.90	0.4
24	64	5	4	0.0745	0.0236	6.4	6.1	5.7	2.92	0.28	10.49	9.62	38	42	19.4	14.8	1.94	0.3
25	66	4	4	0.0785	0.0264	6.4	6.1	5.8	3.11	0.21	11.45	9.64	41	42	20.1	11.9	1.85	0.3
26	67	4	3	0.0733	0.0241	6.4	6.1	5.8	3.03	0.23	11.12	9.71	44	43	19.7	11.3	1.93	0.4
27	68	4	3	0.0712	0.0238	6.4	6.1	5.9	3.14	0.22	10.37	8.15	48	42	18.1	10.1	2.01	0.5
28	61	4	3	0.0754	0.0246	6.4	6.0	5.9	3.48	0.23	10.69	8.44	49	45	17.6	9.4	1.92	0.4
29	70	5	4	0.0699	0.0248	6.2	6.0	5.7	3.33	0.29	10.91	4.34	52	43	18.4	8.9	1.78	0.4
30	82	5	4	0.0721	0.0220	6.3	6.1	5.8	3.45	0.30	11.42	7.03	48	44	19.3	10.3	1.88	0.3
	118.9	14.0	6.7	0.1031	0.0285	6.2	5.5	5.3	7.30	0.33	11.24	4.91	69.1	52.1	19.4	9.9	1.93	0.4

Table C.6.5 Implementation Program of Water Supply Improvement

(Unit: million Pesos)

Item	D/D	Phase I				Phase II				Total
	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Detailed Design Stage										
Construction Stage										
1. Pumping Station		130.1								130.1
2. Purification Plant			155.0	165.0	150.0					470.0
Suarez River Improvement	Start									
Optimum Operation Rule										
a. Hato Dam	Start	Present Conditions		Increase of Water Supply		Start	Future Conditions			
b. Fuquene Lake	Start									
(Investment Cost)										
1. Direct C/C + Land A.	0.0	130.1	155.0	165.0	150.0	0.0	0.0	0.0	0.0	600.1
2. Engin. and Admi. Cost	60.0	13.0	15.5	16.5	15.0	0.0	0.0	0.0	0.0	120.0
3. Physical Contingency	0.0	13.0	15.5	16.5	15.0	0.0	0.0	0.0	0.0	60.0
4. Total	60.0	156.1	186.0	198.0	180.0	0.0	0.0	0.0	0.0	780.1

Note) 1. Figures under bar chart mean Direct Construction Cost and Land Acquisition.
2. Additional O&M cost is negligible.