Chapter 5. Analysis of the "Corporate Water Loss Reduction and Energy Efficiency Program"

5-1 Background of PROGRAM Preparation

This PROGRAM, also known as Corporate Water Loss Reduction and Energy Efficiency Program, integrates into a single program the water loss reduction activities planned to each Business Unit.

The Corporate Water Loss Reduction and Energy Efficiency Program was approved by COFIEX (Foreign Financing Commission of the Ministry of Planning, Budget and Management) on 04/24/2009. COFIEX is constituted of representatives of the Ministry of Finance and Ministry of Planning, Budget and Management, with the purpose of performing the technical evaluation of projects, discussing their validity and making their qualification. In parallel, this project obtained the approval of the Legislative Assembly of the State of São Paulo for JICA financing.

5-2 Targets and Results

5-2-1 Targets

Targets of PROGRAM results are established in Loss Volume per Connection (IPDt) and Loss Rate per Invoice (IPF). The target is to reduce IPDt of 441 (431) liters/connection x day and IPT of 29.6% (27.7%) in 2008 to 211 liters/connection x day and IPF of 13.1% in 2018.

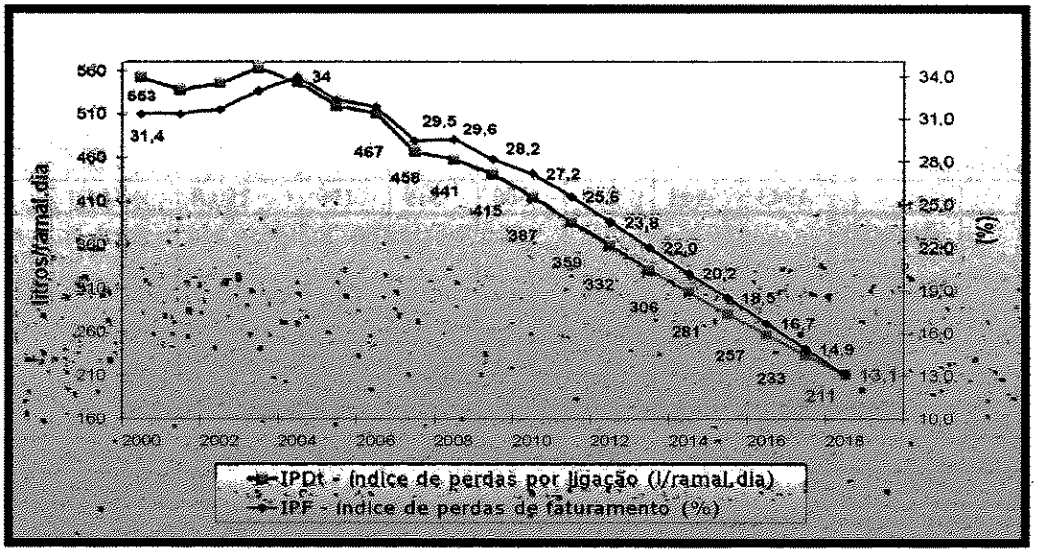

Figure 5-1 Targets for Sabesp Water Loss Reduction

Notes:
Figures for 2008 are estimates considered at the preparation of PROGRAM. Figures between ( ) are achieved figures.

Indicators shown in Figure 5-1 may be changed because of reduction of actions scheduled for 2009-2010. Figures will be reviewed more carefully during the preliminary project.

5-2-2 Expected results

Over the period of 2008-2012, Sabesp must increase the water volume production by 10.5 m^3/sec to meet the increased demand in 366 operated municipalities. This increase corresponds to 11% of total volume produced by Sabesp, and even that new planned water sources are added, the produced volume will not meet the demand.

In this context, the importance of loss reduction is recognized. Through the implantation of the Corporate Water Loss Reduction and Energy Efficiency Program, investments to develop new water resources may be delayed, the water production energy may be reduced, in addition to its contribution to the preservation of water sources used for water supply and hydroelectric power generation, the preservation of the natural environment through the reduction of use of chemicals, as well as other expected benefits.

If water losses cannot be reduced, investing in the development of water resources to supply all water users is urgent, as shown by Figure 5-2, which compares the volume of water to be produced on the basis of increase of water sources currently used by Sabesp and exploration of new water sources in the State of São Paulo to the water demand.

It is expected that, after the loss reduction targets are achieved by the PROGRAM implementation, water resources will be protected by actions focused on sustainability.

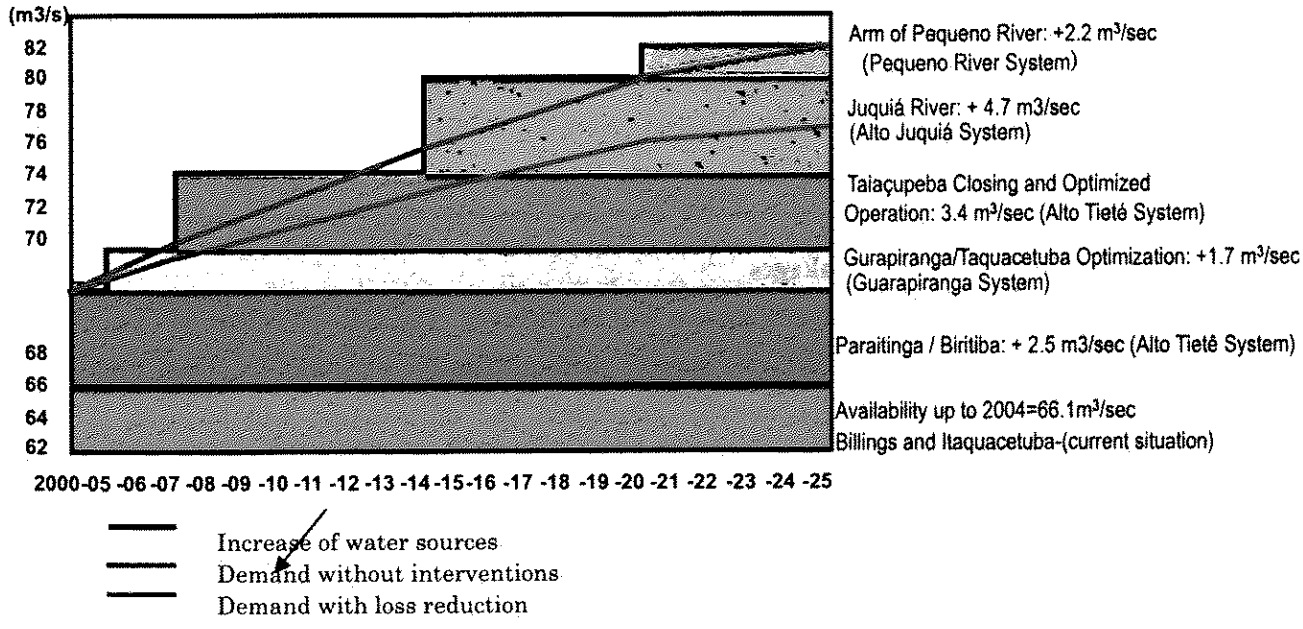

Figure 5-2 – Water demand increase and water resource development plan

5-3 Confirmation of PROGRAM Actions

5-3-1 Actions against real losses

Table 5-1 - Actions against Real losses

Actions against Real losses			
Action	No.	JICA Stage	PROGRAM Total
Branch line replacement	A-1-1	1,086,737 points	3,828,766 points
Network (and branch line) replacement	A-1-2 (Km)	1,042 Km	3,605 Km
	A-1-2 points	117,299 points	401,026 points
Survey of Non-Visible Leakages and Repairs (branch line replacement)	A-1-3	102,530 points	373,594 points
Survey of non-visible leakages	A-2	131,376 km	469,575 km
Repair of visible leakage in networks	A-3-1	137,168 points	489,490 points
Survey of Non-Visible Leakages and Repairs (networks)	A-3-2	13,660 points	48,682 points
Sectorization	A-4-1	147 sectors	302 sectors
VRP Installation	A-4-2	205 units	530 units
DMC	A-4-3	576 districts	1,591 districts
Booster installation	A-4-4	73 points	187 points
Slum area delimitation	A-4-5	3 areas	5 areas
Acquisition of loss control equipment	A-5	1,161 units	4,149 units

Source : Sabesp "Corporate Water Loss Reduction and Energy Efficiency Program" (revised in May 2009)

A1. Networks and Branch Line Replacement

Durability of networks and branch lines will depend on the quality of material and quality of work execution. Branch lines currently implanted are of good quality. Under the PROGRAM, upon the occurrence of branch line leakages, they will be replaced for new branch lines rather than repaired. On the other hand, network lifespan is estimated in 50 years. Under the PROGRAM, because of financial restriction, the criterion for giving priority to poor-conditions areas has been adopted, and 1.7% of network system is intended to be replaced. Network replacement includes related branch-line replacement.

A2. Survey of Non-Visible Leakages

Seventy-five (75%) of total network system will be surveyed. The planned extension of non-visible leakage survey will be the total cyclic surveys performed in the network, To obtain even greater effects, leakage detectors (earphone-type, correlation and other types) will be used, ABENDI qualification will be required from service providers, and surveys will be standardized by field operational criteria, preparation of manuals and previous training in survey practice through capacity building courses. Leakage survey will also be made frequently in repaired or replaced piping, to confirm the efficacy of actions.

A-3. Leakage Repair in Networks

These include repairs in networks with visible and non-visible leakages. Such activities have been performed by UNs, but they will now be performed aiming, in addition to repair time reduction, replacement service standardization, work quality improvement, and elimination of recurrence events

to the extent possible.

A 4. Sectorization, Installation of VRPs, DMCs and Slum Area Delimitation[1]

Sectorization aims to reduce losses by improving the pressure control to allow pressure regulation to avoid impairing water supply. Pressure Reduction Valves (VRPs) and Boosters will be installed to optimize operations. DMCs are Measurement and Control Districts to be implanted basically to measure those data that directly affect the operational management of water supply system, and allow such aspects as discharge and pressure to be monitored. DMCs with an average of 2,000 connections will be implanted. Delimitation of slum areas aims to identify the volume supplied to slums under the PROGRAM, comprising 5 areas. Service will be experimental.

A5. Acquisition of Loss Control Equipment

It is scheduled the acquisition of equipment to support the distribution system monitoring, such as: hearing rod, electronic geophone, portable flow meter, discharge and pressure datalogger, network and metallic mass plotter, non-metallic network plotter, and control for pressure reduction valve.

Actions against Apparent Losses

Table 5-2 - Actions against Apparent losses

Apparent losses			
Action	No.	JICA Stage	PROGRAM Total
Replacement of high-capacity water meter	B 1-1	40,216 units	142,905 units
Replacement of low-capacity water meters	B 1-2	2,345,313 units	8,483,183 units
Inspection of Inactive Connections	B 2-1	1.405,854 points	4,995,292 points
Inspection of irregular connections (water theft)	B 2-2	395,440 points	1,439,690 points
Installation of racks in regularized slums	B 2-3	52,301 points	180,530 points
Record Update	B 3	2,417,436 points	8,739,827 points
UMA installation	B 4	64,050 points	266.767 points

Source: Sabesp "Corporate Water Loss Reduction and Energy Efficiency Program" (revised in May 2009)

B1. Replacement of Water Meters

Over the time, water meter errors increase. Water meter rehabilitation may be divided in 3 cases: corrective replacement, preventive replacement and adequacy. For preventive replacement of low-capacity water meters, frequency has been established in 8 years, and it is scheduled to replace 1/8 every year or a corrective replacement (maintenance) of 10%, as necessary. High-capacity water meter replacement periodicity will be 3 years, and it is scheduled to replace 1/3 every year, in addition to corrective replacement (maintenance) of 10%, as necessary.

B 2. Action against Irregular Connections: Illegal connections; Inspection of inactive

[1] The word "Slum" means illegally occupied housing areas. In these areas there are irregular connections, but it's difficult for SABESP to stop such water supply. Under the viewpoint of the water supply volume analysis, it is important to grasp the volume of running water consumption. For that purpose, first the irregular connections will be intercepted in order to install the macrometers separatelly. After that measure the water pipes will be connected to the branches of "Slum" areas to make it possible to measure the water flow volume.

connections; connections in regularized slums; Installation of Water Measurement Unit (UMA)

It is understood that failing to take any actions against illegal connections (water theft) by users will further encourage illegal acts. Illegal connections (water theft) should be treated severely and continuously. PROGRAM actions include actions against illegal connections (water theft) and inspection of inactive connections. Through activities performed so far, 0.5% – 3.5% of total connections have already been inspected every year. It is reported the identification of any kind of irregularity in some 20% of inspected connections. For such cases, the PROGRAM provided for the installation of a new measurement device called UMA, which will be also installed in new connections requested.

Inspection of inactive connections consists of checking the connections where supply appears as inactive in the customers' database, by virtue of dweller's move or other reasons. The PROGRAM provides for the inspection of all inactive connections.

Slum regularization is the responsibility of the municipality. It rests with Sabesp to make connection in regularized slums.

B 3. Update of Customer Records

Update of customer records is a basic activity. That update aims to confirm the real estate nature, which may be recorded as residential and then changed to commercial or condominium. The program provides for the survey in all cases.

5-3-2 Control and Management of Water Loss and Leakages

Table 5-3 - Control and Management of Water Loss and Leakages

Control and Management of Water Loss and Leakages		
Action	No.	PROGRAM Total
Installation of Macrometers	C 1	803 points
Calibration of macrometers	C 2	9,821 points
Capacity Building	C 3	10,281 training courses
Socioeducative Actions	C 4	R$ 13,500,000
Management Consulting Costs	C 5	R$ 110,000,000

Source: Sabesp "Corporate Water Loss Reduction and Energy Efficiency Program" (revised in May 2009)

C-1. Installation and Adequacy of Macrometers

Installation and/or adequacy of flow measurement equipment with the objective of identify volumes produced, transferred and delivered to Business Units.

C-2. Macrometer Calibration

Periodic calibration of flow macrometers will determine the reliability of volumes obtained. Sabesp

has a methodology developed jointly with the Technological Research Institute of the State of São Paulo – IPT for field macrometer calibration, which will be applied to the implementation of this action.

C3. Capacity Building

Planned capacity building involves activities such as branch line replacements, leakage repairs in network and branch lines, micrometer calibration, inspection of works and services, among other activities focused on water loss control. The activity aims to standardize the work procedures, establish the training system, and improve the technical skills of Sabesp employees. In addition, service providers will also be involved by participating in training sessions and meeting the certification requirement, similar to the application currently adopted by Sabesp for companies that provide non-visible leakage survey services.

Developing this activity is one of objectives to be achieved by Eficaz Program, thus characterizing its full integration with the PROGRAM.

C4 - Socioeducative Actions

These are activities aimed to make the population aware of water loss reduction, mainly focused on slum regularization.

C5. Management Consulting Costs

Action aimed to consultant agreements for PROGRAM implementation management.

5-3-3 Energy Efficiency Program

Table 5-4 – Energy Efficiency Program Actions

Energy Efficiency Program		
Action	JICA Stage	PROGRAM Total
Energy saving in pumps and motors of existing facilities	R$ 29,000,000.00	R$ 29,000,000.00
Review of operational procedures in existing facilities		

Source: Sabesp "Water Loss Reduction and Energy Efficiency Program" (revised in May 2009)

Main scheduled energy efficiency activities: Supply system optimization; Optimization of facility operation (efficient operation of pumps and motors); Optimization of operational system (automation, operational optimization in low-demand hours).

The PROGRAM aims to save energy in water supply system by means of such activities.

Table 5-5 - General PROGRAM Plan (1/2)

		2009	2010	2011	2012	2013	SUBTOTAL	2014	2015	2016	2017	2018	2019	TOTAL
A 1.1 Branch line replacement	Physical (unit)	263,894	232,302	366,318	362,372	358,047	1,086,737	390,736	386,012	372,017	369,551	369,888	357,628	3,828,766
	Financial (R$)	61,152,163	54,091,057	78,020,191	77,197,445	76,319,922	231,537,557	82,982,735	80,615,743	78,302,326	77,707,828	77,537,034	74,221,998	818,148,441
A 1.2 Network and branch line replacement	Physical Network (Km)	157	123	323	351	368	1,042	477	440	395	360	352	261	3,605
	Physical Branch Lines (unit)	14,520	11,398	35,072	40,456	41,770	117,299	53,750	51,060	42,612	42,425	40,689	27,273	401,026
	Financial (R$)	25,893,690	20,376,080	54,797,311	58,832,299	62,243,790	175,873,400	81,262,070	75,798,486	66,985,729	62,972,651	60,262,055	47,804,829	617,228,990
A 1.3 Branch line replacement - Leakage survey	Physical (unit)	22,442	23,447	35,408	32,716	35,406	102,530	39,095	38,902	36,201	38,525	37,640	34,813	373,594
	Financial (R$)	4,845,940	4,997,059	7,133,836	7,133,577	7,133,560	21,400,973	7,688,113	7,659,069	7,253,114	7,602,421	7,469,460	7,044,343	75,960,491
A 1 - Total Infrastructure Renewal	Física Network (Km)	157	123	323	351	368	1,042	477	440	395	360	352	261	3,605
	Physical Branch Lines (unit)	300,856	267,147	436,799	434,544	435,223	1,306,566	483,582	475,974	450,831	450,500	448,217	419,714	4,603,387
	Financial (R$)	91,891,793	79,464,196	139,951,338	143,163,321	145,697,272	428,811,930	171,932,917	164,073,298	152,541,168	148,282,899	145,268,549	129,071,171	1,511,337,922
A 2 - Leakage Survey	Physical (unit)	28,567	29,840	43,793	43,792	43,791	131,376	48,493	48,235	44,860	48,086	46,981	43,138	469,575
	Financial (R$)	5,713,385	6,789,436	9,580,037	9,579,823	9,579,808	28,739,668	10,520,176	10,468,518	9,793,444	10,438,788	10,217,645	9,449,144	102,130,203
A 3.1 Repair of Non-Visivle Leakages n Network	Physical (unit)	41,593	41,213	46,183	45,721	45,264	137,168	45,334	45,756	45,292	44,832	44,377	43,926	489,490
	Financial (R$)	20,920,906	20,730,339	23,319,220	23,086,028	22,855,167	69,260,415	22,898,128	23,123,927	22,889,188	22,656,796	22,426,728	22,198,961	247,305,388
A 3.2 Repair of Non-Visible Leakage (Network)	Physical (unit)	2,539	2,787	4,618	4,424	4,618	13,660	5,434	5,401	4,726	4,984	4,762	4,389	48,682
	Financial (R$)	1,318,800	1,447,937	2,297,720	2,297,680	2,297,678	6,893,079	2,620,314	2,602,751	2,353,495	2,487,602	2,372,687	2,178,825	24,275,489
A 3 - Total Repair	Physical (unit)	44,131	44,000	50,801	50,145	49,882	150,828	50,768	51,157	50,017	49,816	49,139	48,316	538,171
	Financial (R$)	22,239,707	22,178,276	25,616,940	25,383,708	25,152,846	76,153,494	25,518,442	25,726,678	25,242,682	25,144,398	24,799,415	24,377,785	271,380,877
A 4.1 Sectorization (Implantationof Pressure Zones)	Physical - project (unit)	6	5	19	11	5	34	15	10	7	2	2	3	83
	Physical - work (unit)	6	18	19	47	47	113	26	14	11	18	11	4	219
	Financial (R$)	13,812,589	46,181,936	60,861,396	59,301,746	26,726,047	146,889,189	69,960,574	36,088,558	12,020,831	13,398,159	7,782,392	1,747,599	347,881,827
A 4.2 VRP	Physical (unit)	80	79	94	56	55	205	69	28	22	19	15	13	530
	Financial (R$)	8,052,731	7,893,350	7,845,751	4,765,000	4,619,750	17,230,500	5,802,985	2,427,000	1,897,000	1,685,500	1,317,500	1,089,000	47,395,566
A 4.3 Dist measurement control	Physical (unit)	83	102	210	189	177	576	277	188	108	96	90	72	1,591
	Financial (R$)	3,318,000	4,068,704	8,407,185	7,546,105	7,085,310	23,038,600	11,077,297	7,552,188	4,308,603	3,838,323	3,591,893	2,881,241	63,674,851
A 4.3 Booster	Physical (unit)	21	11	30	26	17	73	32	24	9	8	4	5	187
	Financial (R$)	4,924,100	4,318,590	5,192,500	2,047,572	869,300	8,109,372	1,554,720	1,279,728	497,215	442,750	272,350	292,790	21,691,615
A 4.4 Skim Closing	Physical (una)	0	1	1	1	-	3	1	0	-	-	-	-	5
	Financial (R$)	195,000	215,000	770,000	720,000	-	1,490,000	455,000	110,000	-	-	-	-	2,465,000
A 4 - Total Sectorization	Physical (unit)	190	210	354	319	296	970	404	254	150	141	120	93	2,533
	Financial (R$)	30,302,419	62,677,580	83,076,832	74,380,422	39,300,407	196,757,662	88,850,576	47,457,474	18,723,649	19,364,732	12,964,136	6,010,630	483,108,858
A 5 - Equipment	Physical (unit)	587	344	443	393	325	1,161	541	398	328	246	276	268	4,149
	Financial (R$)	6,631,775	4,762,320	5,583,000	4,285,200	3,426,250	13,294,450	6,565,375	4,875,350	3,717,850	2,787,250	3,086,850	3,482,650	49,203,870
Total Real Loss	Financial (R$)	156,779,079	175,871,868	263,808,147	256,792,473	223,156,583	743,757,203	303,387,487	252,601,318	210,018,794	206,018,067	196,336,594	172,391,380	2,417,161,731

Table 5-5 – General PROGRAM Plan (2/2)

		2009	2010	2011	2012	2013	SUBTOTAL	2014	2015	2016	2017	2018	2019	TOTAL
B 1.1 Substituição Hidro Gde Capacidade	Físico (un)	13,034	12,428	13,366	13,425	13,425	40,216	11,827	13,042	13,039	13,051	13,129	13,137	142,805
	Financeiro (R$)	3,673,034	3,509,888	3,168,278	3,075,625	3,075,625	9,319,528	2,709,676	2,987,802	2,987,260	2,990,063	3,007,970	3,009,805	34,195,024
B 1.2 Substituição Hidro Pequena Capacidade	Físico (un)	709,035	667,187	781,771	781,771	781,771	2,345,313	832,198	805,543	775,399	782,836	782,836	782,836	8,483,183
	Financeiro (R$)	36,782,752	37,384,188	45,053,370	45,053,370	45,053,370	135,160,110	48,007,645	46,411,805	44,607,094	45,018,944	45,018,944	45,018,944	483,410,425
B 1 - Total Substituição de Hidros	Físico (un)	722,069	679,615	795,137	795,196	795,196	2,385,529	844,025	818,584	788,438	795,887	795,966	795,974	8,626,087
	Financeiro (R$)	40,455,786	40,894,075	48,221,648	48,128,995	48,128,995	144,479,638	50,717,322	49,399,606	47,594,354	48,009,007	48,026,913	48,028,748	517,605,449
B 2.1 - Inspeção Inativos	Físico (un)	367,312	368,021	468,618	468,618	468,618	1,405,854	475,684	475,684	475,684	475,684	475,684	475,684	4,995,292
	Financeiro (R$)	5,190,125	5,200,142	6,621,572	6,621,572	6,621,572	19,864,717	6,721,415	6,721,415	6,721,415	6,721,415	6,721,415	6,721,415	70,583,474
B 2.2 - Combate Irregulares - Inspeção	Físico (un)	91,405	91,541	131,811	131,825	131,803	395,440	159,751	142,695	139,714	139,714	139,714	139,714	1,439,690
	Financeiro (R$)	4,362,187	4,367,187	4,857,240	4,840,660	4,856,955	14,554,855	5,891,481	5,262,975	5,153,120	5,153,120	5,153,120	5,153,120	55,051,163
B 2.3 - Regularização Favelas	Físico (un)	8,363	13,399	17,329	17,375	17,598	52,301	24,606	21,032	19,151	18,609	16,021	7,048	180,530
	Financeiro (R$)	3,388,894	5,433,579	7,027,143	7,027,030	7,117,550	21,171,724	9,959,510	8,509,944	7,747,308	7,527,502	6,478,009	2,841,857	73,058,327
B 2 - Total Combate a Irregulares	Físico (un)	467,081	472,961	617,758	617,818	618,019	1,853,595	660,041	639,411	634,549	634,007	631,419	622,446	6,615,512
	Financeiro (R$)	12,941,205	15,000,907	18,505,856	18,489,263	18,596,077	55,591,296	22,572,406	20,494,334	19,621,843	19,402,037	18,352,543	14,716,391	198,692,863
B 3 - Atualização Cadastral	Físico (un)	491,630	492,718	805,812	805,812	805,812	2,417,436	931,694	954,668	862,099	906,463	882,574	800,544	8,739,827
	Financeiro (R$)	2,217,253	2,222,159	3,634,212	3,634,214	3,634,211	10,902,637	4,201,840	4,305,551	3,888,068	4,088,149	3,980,410	3,610,454	39,416,620
B 4 - Instalação UMA Irregulares	Físico (un)	8,061	8,539	21,349	21,350	21,352	64,050	43,238	30,444	28,014	28,014	28,011	28,395	266,767
	Financeiro (R$)	3,095,542	3,279,026	8,187,874	8,198,258	8,199,026	24,595,159	16,603,421	11,690,549	10,757,338	10,757,338	10,756,198	10,803,863	102,438,434
Total Perdas Aparentes	Financeiro (R$)	58,709,787	61,386,167	78,556,680	78,450,730	78,556,310	235,568,729	84,085,069	85,880,040	81,861,602	82,256,531	81,116,064	77,259,456	858,153,466
C 1 - Instalação / Adequação de Macromedidores	Físico (un)	56	60	129	89	64	282	161	56	46	52	48	41	803
	Financeiro (R$)	3,386,244	4,108,446	5,990,200	4,546,740	4,608,050	15,144,990	7,654,304	2,143,939	1,674,703	1,894,603	1,746,292	1,485,592	39,241,114
C 2 - Calibração de Macromedidores	Físico (un)	351	538	905	907	909	2,722	1,147	1,149	968	988	987	972	9,821
	Financeiro (R$)	565,140	1,845,220	2,549,900	2,553,728	2,557,556	7,661,183	2,872,107	2,875,935	2,645,573	2,677,059	2,675,431	2,661,696	26,479,344
C 3 - Capacitação	Físico (un)	1,605	677	1,346	516	1,219	3,060	536	1,250	461	1,194	442	1,034	10,281
	Financeiro (R$)	521,132	389,376	718,119	545,190	645,268	1,908,576	618,081	719,066	448,396	571,466	404,731	451,076	6,031,903
C 4 - Ações Sócio Educativas	Financeiro (R$)	1,227,273	1,227,273	1,227,273	1,227,273	1,227,273	3,681,818	1,227,273	1,227,273	1,227,273	1,227,273	1,227,273	1,227,273	13,500,000
C 5 - Demanda da Diretoria de Tecnologia e Meio Ambiente (Gerenciamento)	Financeiro (R$)	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	30,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	110,000,000
Total Gestão	Financeiro (R$)	15,791,789	17,570,316	20,485,491	18,872,930	19,038,146	58,396,567	22,371,766	16,966,213	15,995,945	16,370,401	16,053,728	15,825,638	195,252,362
Eficiência Energética	Financeiro R$	-	-	15,000,000	14,000,000	-	29,000,000	-	-	-	-	-	-	29,000,000
Total Geral	Financeiro R$	231,180,854	254,938,291	377,853,328	383,118,133	320,753,039	###########	419,854,941	355,457,571	307,875,342	304,844,999	293,506,386	285,476,475	3,496,567,559

5-4 Technical Evaluation

5-4-1 Methodology for definition and selection of PROGRAM components (actions)

• Selection of Priority Group

PROGRAM coordinating unit evaluated the performance indicators of supply systems related to December 2007 in a total of 366 municipalities that comprise 502 systems. By using "ABC curve" analysis methodology, it was determined that 158 systems had values above 346 liters/connections/day (IPDt), which account together for 80% of total loss volume.
This 158-system group was named "Priority Group".

For all 158 systems selected as Priority Group, the following components (actions) are scheduled (quantity of components are shown in Table 5-6).

- Replacement of networks (including branch lines);
- Sectorization;
- VRP Installation;
- Booster installation.

Network replacement will focus on such 158 systems. With the objective of improving control management and control in the distribution network, the installation of VRP and Boosters and/or adequacy of supply sectors bas been planned. Such actions may apply to systems not included in the Priority Group, according to criteria established by UNs.

Table 5-6 – Actions for the Priority Group

Priority Actions		
Actions	**Quantity**	**No.**
Replacement of networks (including branch lines)	3,605 Km	A-1-2 (Km)
VRP Installation	530 units	A-4-2
Sectorization	302 sectors	A-4-1
Booster installation	187 units	A-4-4

Source: Sabesp "Water Loss Reduction and Energy Efficiency Program" (revised in May 2009)

Using IPDt, which is one of indicators that shows the relative reality of water supply network and the size of systems as a criterion for the first choice and demarcation line of Priority Group, will cause no problems.

• Components (Actions) of the WHOLE Group

If on one side the Priority Group was selected, there will also be components (actions) that will be implanted in all 500 systems. This group of 500 systems will be called WHOLE Group to be differentiated from the Priority Group. The components of ALL Group are listed below, the quantity of which is shown in Table 5-7.

- Branch line replacement;
- Survey of non-visible leakages;
- Leakage Repair in network;
- DMC;
- Record Update;
- Replacement of high-capacity and low-capacity water meters;
- Irregularity control;
- Regularization of connections in slums;
- Installation of Macrometers;
- Calibration of macrometers;
- Capacity Building;
- Acquisition material resources.

Table 5-7 – Components (actions) for the WHOLE Group

WHOLE Group			
Action		Quantity	No.
Branch line replacement		4,603,386 branch lines	A 1-1, A 1-2, A 1-3
Survey of non-visible leakages		469,575 Km	A 2, A 3-2
Leakage Repair		538,172 repairs	A 3-1, A 3-2
Measurement and Control District - DMC		1,591 units	A 4-3
Replacement of water meters		8,626,088 units	B 1-2, B 1-1
Irregularity control	Inspection of inactive connections	4,995,292 units	B 2-1
	Inspection of illegal connections (water theft)	1,439,690 units	B 2-2
	UMA installation	266,767 units	B 4
Update of Customer Records		8,739,827 units	B 3
Slum action	Slum are delimitation	5 areas	A 4-5,
	Connections in regularized slums	180,530 units	B 2-3
	Population's awareness	R$ 13,500,000.00	C 4
Installation of Macrometers		803 units	C 1
Macrometer Calibration		9,821 units	C 2
Capacity building of Sabesp employees		10,281 training courses	C 3
Acquisition of loss control material and equipment		4,149 units	A 5

Source: Sabesp "Water Loss Reduction and Energy Efficiency Program" (revised in May 2009)

As shown in Table 5-7 for the WHOLE Group, target areas of actions include all systems, regardless of their classification, taking into consideration the IPDt indicator. Components of this group include general loss reduction, such as basic actions, corrective actions, preventive actions, distribution adjustment actions, and social actions. For selection of target areas and setting of quantities by UNs, in addition to loss management indicators, such as IPDt), other indicators expressing correctly the level of deterioration of piping systems will be used for the preparation of a n effective replacement plan.

• Differences between M and R

For the Priority Group, 114 Metropolitan (M) systems and 44 Regional (R) Systems (municipalities) were selected.

Table 5-8 shows the evolution of water loss control indicators in Metropolitan (M) and Regional (R) Divisions. In 2008, the loss rate (IPF) recorded was 28.0% for M and 27.1% for R; however, the loss volume per connection (IPDt) was 510 l/connection/day in M and 315 in R.

Table 5-8 – Water Loss Control Indicators

Loss Rate per Invoice (IPF) (%)										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Sabesp	**30,6**	**31,4**	**31,4**	**31,7**	**33,0**	**34,0**	**32,4**	**31,9**	**29,5**	**27,7**
Metropolitan (M)	30,1	30,9	30,7	31,4	32,7	34,9	32,9	32,5	29,8	28,0
Regional (R)	32,2	32,5	33,3	32,5	33,7	31,4	31,1	30,1	28,9	27,1
Loss Rate per Connection (IPDt) (l/connection x day)										
		2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Sabesp		**554**	**538**	**546**	**563**	**547**	**523**	**511**	**468**	**433**
Metropolitan (M)		651	629	652	676	601	546	543	493	451
Regional ®		409	406	393	400	369	366	351	338	314

Source : Sabesp, Business Management Report.

5-5 Financial Evaluation

5-5-1 Cost of PROGRAM per action

Investments and expenses throughout the 11-year Program amounts to R$ 3.5 billion, which is broken down per action as follows: 69.1% for leakages; 24.5% for different losses from leakages; 5.6% for real and apparent loss control and management; and 0.8% for energy efficiency.

Table 5-9 - Cost of PROGRAM peer Action (in R$ million)

		Action	Total	Percent Composition (%)
1	A 1-1	Branch line replacement	818.1	23.4%
2	A 1-2	Replacement of networks (including branch lines)	617.2	17.6%
3	A 1-3	Survey of Non-Visible Leakages and Repairs (branch line replacement)	76.0	2.2%
	A 1	**Total network and branch line replacement**	**1,511.3**	**43.2%**
4	A 2	Survey of non-visible leakages	102.1	2.9%
5	A 3-1	Visible Leakage Repair in Network	247.1	7.1%
6	A 3-2	Survey of Non-Visible Leakages and Repairs (Network)	24.3	0.7%
	A 3	**Total Repair**	271.4	7.8%
7	A 4-1	Sectorization	347.9	9.9%
8	A 4-2	VRP Installation	47.4	1.4%
9	A 4-3	DMC	63.7	1.8%
10	A 4-4	Booster installation	21.7	0.6%
11	A 4-5	Slum are delimitation	2.5	0.1%
	A 4	**Total Sectorization**	483.1	13.8%
12	**A 5**	**Acquisition of loss control equipment**	49.2	1.4%
	A	**Action against Leakages**	**2,417.2**	**69.1%**
13	B 1-1	Replacement of High-Capacity Water Meters	34.2	1.0%
14	B 1-2	Replacement of Low-Capacity Water Meters	483.4	13.8%
	B 1	**Total Water Meter Replacement**	517.6	14.8%
15	B 2-1	Inspection of inactive connections	70.6	2.0%
16	B 2-2	Inspection of illegal connections (water theft)	55.1	1.6%
17	B 2-3	Connections in regularized slums	73.1	2.1%
	B 2	Subtotal Irregularity Control	198.7	5.7%
18	B 3	Record Update	39.4	1.1%
19	B 4	UMA installation	102.4	2.9%
	B	**Action against Different Losses from Leakage**	**858.2**	**24.5%**
20	C 1	Installation of Macrometers	39.2	1.1%
21	C 2	Calibration of macrometers	26.5	0.8%
22	C 3	Capacity Building	6.0	0.2%
23	C 4	Socioeducative Actions	13.5	0.4%
24	C 5	Management Consulting Costs	110.0	3.1%
	C	**Total Management**	**195.3**	**5.6%**
25	**D**	**Energy Efficiency**	**29.0**	**0.8%**
		Grand Total	**3,499.6**	**100.0%**

Source: Sabesp Corporate Water Loss Reduction Program" (revised in May 2009)

5-5-2 Adequacy of Corporate Water Loss Reduction Program

Analysis of fundaments for investments fundamentals and expenses per action was based on the following documents:

- Revised version of the "Sabesp Corporate Water Loss Control and Reduction Program". FT/TO, Sabesp, May 2009).
- "Manual of Assumptions and Parameters Adopted in Loss Program Study", Sabesp, December 2008.

Table 5-10 – Formula for calculation the cost per component of PROGRAM

No.	Action	Formula
A	**Real Loss**	
A1.1	Branch line replacement	Investment = (average branch line replacement cost-R$) x (Number of branch lines replaced)
A1.2	Network and branch line replacement	Investment = (Average network replacement cost-R$/km) x Length of network replaced-km) Investment = (Average branch lime replacement cost-R$/unit) x Number of branch lines replaced-unit)
A1.3	Branch Line Replacement – Leakage Survey	Investment = (Average branch lime replacement cost-R$/unit) x Number of replaced leaking branch lines-unit)
A2	Leakage Survey	Expenditure = (Average survey cost) x (Surveyed network -km) + (Average network preparation cost-R$/unit) x (Number of network points repaired –unit)
A3.1	Visible Leakage Repair in Network	Expenditure = (Average network repair cost-R$/unit) x (Number of network points repaired –unit)
A3.2	Non-Visible Leakage Repair (Network)	Expenditure = (Average leakage survey cost-R$/km) x (Length of surveyed network -km) Investment = (Average network repair cost-R$/unit) x (Number of network points repaired –unit)
A4.1	Sectorization (Implantation of Pressure Zones)	Investment = (Average sectorization cost) x (Sectorizations - units)
A4.2	VRP	Investment = (Average VRP unit cost) x (Number of VRP installed).
A4.3	Measurement and Control District	Investment = (Average DMC unit cost) x (Number of DMC installed).
A4.4	Booster	Investment = (Average Booster unit cost) x (Number of Boosters installed).
A4.5	Slum Closing	Investment = (Unit cost of micrometer installation× (Number of slums to regularize)
A5	Equipment	Required equipment will be listed and each UN will calculate the respective costs
B	**Apparent Loss**	
B1.1	Replacement of High-Capacity Water Meters	Investment = (Average water meter cost) x (Water meters replaced - units)
B1.2	Replacement of Low-Capacity Water Meters	Investment = (Average water meter cost) x (Water meters replaced - units)
B2.1	Inactive inspections	Expenditure = (Average survey cost) x (Number of inactive connections surveyed –units)
B2.2	Control of illegal connections - Inspection / UMA installation	Expenditure = (Average survey cost) x (Irregular connections surveyed -unit) Investment = (Average UMA installation cost) x (Number of irregular connections –unit)
B2.3	Slum regularization	Investment =(Unit cost of connection × (Number of slums to regularize)
B3	Record Update	Expenditure = (Average record update cost) x (Number of records)
C	**Total - Management**	
C1	Installation / Adequacy of Macrometers	Investment = (Average micrometer unit cost) x (Number of macrometers installed).
C2	Macrometer Calibration	Expenditure = (Average calibration cost) x (Number of macrometers calibrated –units)
C3	Capacity Building	Expenditure = (Average training unit cost) x (Number of trained peoples – individual/day)
C4	Socioeducative Actions	Expenditure = (Unit cost of presentation) x (Number of presentations – times)
C5	Demand from Technology and Environment Division (Management)	Expenditure = (Management unit price) x (Required man-hours – individual/month)

5-5-3 Adequacy of calculation of PROGRAM benefits

Under Sabesp PROGRAM, the following items are considered as financial benefits:

(1) Reduction of water treatment costs;
(2) Reduction of electric power costs;
(3) Reduction of maintenance costs per leakage volume reduction through facility replacement;
(4) Reduction of costs from investment postponement;
(5) Reduction of operational costs through operation managers training;
(6) Revenue increase from fraud reduction.

◆ Methodology for calculation of Loss Program Benefits

The benefit considers the income from the sale of avoided leakage volume (referred to as recovered volume) as a result o loss control actions, which will be used for new demands. This includes chemicals, electric power, maintenance and management costs.

Recovered volume has a sale potential to meet repressed demand, natural demand increase and others, and the recorded revenues assume such cases. That estimate includes water and sewerage tariffs, where 80% of water tariff is charged to sewerage.

By reducing the apparent losses through increased water meter accuracy, regularization of illegal connections and other factors, revenue increase calculated by multiplying the recovered volume by the average tariff rate is recorded as benefit.

It the sale is possible, cost of non-billed water and taxes will be deducted of the sale price.

Recovered volume, as a base for benefit calculations, is calculated per action, according to the equations shown in Table 5-11 below.

"Recovered water volume" means the water volume that, after the implementation of leakage prevention actions, is no longer lost and is converted into revenue from its sale to other consumers. This water revenue is indicated by (1), and sewerage revenue is indicated by (2).

Table 5-11 - Formulas for recovered water volume calculation

No.	Action	Formula
A	**Real Loss**	
A1.1	Branch line replacement	(Average recovered volume in m³/h) x (Number of leakage hours per year) x (Number of branch lines replaced) x (Recovery profile-%).
A1.2	Network and branch line replacement	Average recovered volume in m³/h/km) x (Number of hours peer year) x (Length (km) of renewed area) x recovery profile.
A1.3	Branch Line Replacement – Leakage Survey	Idem A1.1
A2	Leakage Survey	Recovered water volume not calculated.
A3.1	Visible Leakage Repair in Network	Average recovered volume in m³/h) x (Number of hours per month) x (Number of leakages to be repaired x (Leakage time (months) x Recovery profile.
A3.2	Non-Visible Leakage Repair (Network)	Idem A3.1
A4.1	Sectorization (Implantation of Pressure Zones)	(Average recovered volume in m³/h) x Number of seconds per year) x (Number of sectors to be implanted x Recovery profile.
A4.2	VRP	Average volume recovered by VRP in m3/h x Number of seconds per year) x (Number of VRPs to be implanted x Recovery profile.
A4.3	Measurement and Control District	Recovered water volume not calculated.
A4.4	Booster	Recovered water volume not calculated.
A4.5	Slum Closing	Recovered water volume not calculated.
A5	Equipment	Recovered water volume not calculated.
B	**Apparent Loss**	
B1.1	Replacement of High-Capacity Water Meters	(Average recovered volume per replaced water meter in m³/h) x Number of months per year x Number of water meters replaced) x Recovery profile.
B1.2	Replacement of Low-Capacity Water Meters	(Average recovered volume per replaced water meter in m³/h) x Number of months per year x Number of water meters replaced) x Recovery profile.
B2.1	Inactive inspections	(Average recovered volume per reactivated connection in m³/h) x Number of months per year x Number of connections reactivated x Average volume recovered by suppressed connection in m³/h) x Number of months per year x Number of connections suppressed x Recovery profile.
B2.2	Control of illegal connections - Inspection / UMA installation	Average recovered volume per fraud detected in m³/h x Number of months per year x Number of irregular connections x Recovery profile x Retroactive billing.
B2.3	Slum regularization	Average recovered volume per connection installation in m³/h x Number of months per year x Number of connections installed x Recovery profile.
B3	Record Update	Recovered water volume not calculated.
C	**Total - Management**	
C1	Installation/Adequacy of Macrometers	Recovered water volume not calculated.
C2	Macrometer Calibration	Recovered water volume not calculated.
C3	Capacity Building	Recovered water volume not calculated.
C4	Socioeducative Actions	Recovered water volume not calculated.
C5	Demand from Technology and Environment Division (Management)	Recovered water volume not calculated.

Note: Prepared by JICA survey team, based on data provided by Sabesp.

The following pages show the estimated calculation base of benefits per each PROGRAM component

Table 5-12 – Financial Analysis Assumption (1/2)

No.	Component	REVENUE		Deductions	
		(1) Net Water Revenue	(2) Net Sewerage Revenue	Revenue Evasion	Cofins / Pasep
A	Total Real Loss				
A1.1	Branch line replacement	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
A1.2	Network and branch line replacement	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
A1.3	Branch Line Replacement – Leakage Survey	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
A2	Leakage Survey				
A3.1	Visible Leakage Repair in Network	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
A3.2	Non-Visible Leakage Repair (Network)	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
A4.1	Sectorization (Implantation of Pressure Zones)	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
A4.2	VRP	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
A4.3	Measurement and Control District				
A4.4	Booster				
A4.5	Slum Closing				
A5	Equipment				
B	Total Apparent Losses				
B1.1	Replacement of High-Capacity Water Meters	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
B1.2	Replacement of Low-Capacity Water Meters	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
B2.1	Inactive inspections	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep		
B2.2	Irregularity Control - Inspection	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
B2.2	UMA Installation	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Recovered Volume x Percentage of volume for sale x Percentage of collection (Sale to TL1 segment) x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep	Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
B2.3	Slum regularization	Recovered Volume x Percentage of volume for sale x Average tariff = Gross Revenue – Revenue Evasion – Cofins-Pasep		Gross Revenue x Revenue Evasion %	Gross Revenue x Cofins-Pasep %
B3	Record Update				
C	Total - Management				
C1	Installation / Adequacy of Macrometers				
C2	Macrometer Calibration				
C3	Capacity Building				
C4	Socioeducative Actions				
C5	Demand from Technology and Environment Division (Management)				

Table 5-13 - Financial Analysis Assumption (2/2)

No.	Component	COST REDUCTION		REDUCTION FROM MAINTENANCE	
		(3) Reduction of electric power costs	(5) Reduction of treatment material costs	(5) Reduction of branch line maintenance costs	(6) Reduction of network maintenance costs
A	Total Real Loss				
A1.1	Branch line replacement	(Recovered volume – Volume for sale) x Electric Power Cost/m³	(Recovered volume – Volume for sale) x Treatment Material Cost/m³	Average repair cost x Number of avoided repairs per branch line x Number of branch lines replaced	
A1.2	Network and branch line replacement	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3	Average repair cost x Number of avoided repairs per branch line x Number of branch lines replaced x Length (km) of network renewed	Average repair cost x Number of avoided repairs per km x Length (km) of network renewed
A1.3	Branch Line Replacement – Leakage Survey	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3	Average repair cost x Number of avoided repairs per branch line x Number of branch lines replaced	
A2	Leakage Survey				
A3.1	Visible Leakage Repair in Network	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3		
A3.2	Non-Visible Leakage Repair (Network)	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3		
A4.1	Sectorization (Implantation of Pressure Zones)	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3	Leakage per branch line (m³/conn./year) x Average network length per sector (Km) x Number of connections per Km x Number of sectors to be implanted (unit) x Average cost of branch line repair	Leakage per branch line (m³/conn./year) x Average network length per sector (Km) x Number of connections per Km x Average cost of network repair
A4.2	VRP	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3	Leakage per branch line (m³/conn./year) x Average network length per sector (Km) x Number of connections per Km x Number of VRPs to be implanted (unit) x Average cost of branch line repair	Leakage per branch line (m³/conn./year) x Average network length per sector (Km) x Number of VRPs to be installed (unit) x Average cost of network repair
A4.3	Measurement and Control District				
A4.4	Booster				
A4.5	Slum Closing				
A5	Equipment				
B	Total Apparent Losses				
B1.1	Replacement of High-Capacity Water Meters	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3		
B1.2	Replacement of Low-Capacity Water Meters	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3		
B2.1	Inactive inspections	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3		
B2.2	Irregularity Control - Inspection	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3		
B2.2	UMA Installation	(Recovered volume – Volume for sale) x Electric Power Cost/m3	(Recovered volume – Volume for sale) x Treatment Material Cost/m3		
B2.3	Slum regularization	(Recovered volume – Volume for sale) x Electric Power Cost/m3			
B3	Record Update				
C	Total - Management				
C1	Installation/Adequacy of Macrometers				
C2	Macrometer Calibration				
C3	Capacity Building				
C4	Socioeducative Actions				
C5	Demand from Technology and Environment Division (Management)				

The portion of the recovered volume that will not be sold will enable the produced volume to be reduced. As a result of that reduction, costs of electric power and chemicals for water treatment will also be reduced. They are indicated by (3) and (4), respectively.

Upon the implementation of network and branch line replacement works, new leakage occurrences will decrease. Cost reduction from network repairs is indicated by (5), and from branch line repairs is indicated by (6).

5-5-4 Financial Evaluation

At the end of May, JICA F/S Mission received from Sabesp the financial analysis documents related to the "Corporate Water Loss Reduction and Energy Efficiency Program" (revised May 2009). One of such documents refers to the calculation of benefits to expenditures and another refers to the borrowing plan (2008-2013), which provides for Yen financing.

The financial evaluation of the PROGRAM was based on such documents.

◆ Internal Rate of Return (IRR) of Revised PROGRAM

Calculation of investments and expenditures considers all scheduled actions (real losses, apparent losses, management).

Basis for costs and benefits per action was not changed from the original version.

The estimated period is 50 years from 2009, as some actions will produce impacts for a period of 40 years, annual costs and benefits will be evidenced, values will be to the present value at the discount rate of 12%, and Net Present Value (NPV) and the Internal Return Rate (IRR) will be calculated by the net cost-benefit. IRR calculated in this document may be considered as the Financial Internal Rate of Return (FIRR), based on financial benefit generated by the real financial calculation.

The important aspect of benefit calculation is the percentage of marketable recovered volume. Based on the estimated demand, sale potential is calculated for two scenarios - 75% and 60%.

For scenario 1, 60% sale potential, FIRR = 3.36%. This is lower than Sabesp average borrowing cost of 9%.

For scenario 2, 75% sale potential, FIRR = 15.28%. As it exceeds Sabesp average borrowing cost of 9%, and average borrowing cost in the market, the Program is financially adequate.

Table 5-14 - Financial Internal Rate of Return - FIRR

	Scenario 1	Scenario 2
Sold Volume / Recovered Volume (%)	60%	75%
Internal Rate of Return (IRR)	3.36%	15.28%
Net Present Value (NPV) (R$ 1,000)	-266,934	76,438
Total benefits (current value) (R$ 1,000)	1,808,720	2,152,092
Total costs (current value (R$ 1,000)	2,075,654	2,075,654
Investments (current value) (R$ 1,000)	1,730,809	1,730,809
Expenditures (current value) (R$ 1.000)	544,845	544,845

Source: Sabesp

◆ **Economic Internal Rate of Return (FIRR) of Revised PROGRAM**

Benefits from investment postponement may be considered as social benefits. ITT added of such benefits may be called Economic Internal Rate of Return (EIRR). (In principle, EIRR needs to be adjusted, as it is not necessary to be deducted of taxes and other charges that are economic transfers to the population. However, the calculation above was a simple addition of benefit from investment postponement to the financial benefit.

The current value of benefit from investment postponement is R$ 112,133,000, and EIRR is 4.48% for Scenario 1, and 27.84% for Scenario 2.

◆ **Investment Plan (2008-2013)**

Table 5-15 below shows Sabesp general cash flow based on revised Corporate Program. The basic structure is the same for Sabesp long-term flow of funds shown in Table 4-13. Item "12-Investments" indicates the amounts of stage financed by JICA. Investments include: R$ 1.3 billion in 2011, R$ 1.16 billion in 2012 and R$ 1.28 billion in 2013, of which R$ 360 million 2011, R$ 360 million in 2012 and R$ 300 million in 2013 will be allocated to the Water Loss Program, accounting for approximately 30% of annual investments.

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Cia de Saneamento Básico do Estado de São Paulo - SABESP

Plurianual Budget (2009 - 2013)

Table 5-15 Budget Cash Flow - 2008-2013 (analytic)

R$ million (current)

Description	2008	2009	2010	2011	2012	2013
1. Opening Balance	195	344	100	484	109	290
2. Net Operating Income	6.421	6.823	7.205	7.766	8.327	8.899
2.1. Net Sales	**7.115**	**7.525**	**8.188**	**8.829**	**9.509**	**10.185**
2.1.1.UN's (Priv, Munic, Fed)	6.114	6.475	7.041	7.588	8.139	8.718
2.1.2. Concessionaires	324	356	390	413	439	461
2.1.3. GESP	346	363	383	401	419	444
2.1.4. Municipal Government of São Paulo	121	128	138	147	156	166
2.1.5. São Bernardo do Campo	180	202	236	280	357	396
2.2 Default	**[195]**	**[252]**	**[323]**	**[351]**	**[395]**	**[447]**
2.2.1.UN's (Priv, Munic, Fed)	[338]	[237]	[265]	[285]	[306]	[325]
2.2.2. Concessionaires	[105]	[82]	[121]	[129]	[136]	[87]
2.2.3. GESP	244	32	35	39	42	0
2.2.4. Municipal Government of São Paulo	[4]	53	49	49	36	0
2.2.5. São Bernardo do Campo	7	[18]	[20]	[24]	[31]	[34]
2.3. Gross Operating Income	**6.919**	**7.273**	**7.865**	**8.478**	**9.114**	**9.738**
2.3.1.UN's (Priv, Munic, Fed)	**5.819**	**6.252**	**6.791**	**7.318**	**7.848**	**8.408**
2..3.1.1.UN's - Normal	5.575	5.913	6.463	6.973	7.491	8.036
2.3.1.2.UN's - Pub Municipal Entity Acc Closing	19	14	2	2	3	2
2.3.1.3.UN's Joint Ventures	225	325	326	343	354	371
2.3.2. Concessionaires	**218**	**274**	**269**	**284**	**303**	**374**
2.3.3.1. Water + Sewerage	187	238	240	255	273	289
2.3.3.2.Public debts	31	36	29	29	29	85
2.3.3.GESP	**591**	**395**	**418**	**439**	**462**	**444**
2.3.3.1. GESP Normal Income	341	363	383	401	419	444
2.3.3.2. Income from GESP Agreement	221	-	0	0	0	0
2.3.3.3.Instalments Received from GESP Agreement	29	32	35	39	42	0
2.3.4. Municipal Government of São Paulo	**117**	**182**	**186**	**195**	**192**	**166**
2.3.4.1. Revenue Flow	117	128	138	147	156	166
2.3.4.2. Debts Received	-	53	49	49	36	0
2.3.5. São Bernardo do Campo	**188**	**185**	**215**	**256**	**326**	**361**
2.3.6. Reimbursement of Undue Water Bill Vis	**[14]**	**[14]**	**[15]**	**[15]**	**[15]**	**[15]**
2.4. Joint Venture Expenses	**[37]**	**[57]**	**[61]**	**[68]**	**[70]**	**[73]**
2.5. Other Income	**55**	**181**	**26**	**30**	**9**	**11**
2.6. Deduction of Cofins/Pasesp	**[516]**	**[575]**	**[625]**	**[674]**	**[726]**	**[778]**
3. Operating Expenses	3.063	3.513	3.695	3.940	4.099	4.431
3.1.Personnel	**1.407**	**1.532**	**1.512**	**1.551**	**1.618**	**1.689**
3.1.1.Personnel	1.359	1.371	1.437	1.495	1.560	1.629
3.1.2.PDV/PEA	-	107	20	0	0	0
3.1.3.PLR	48	54	55	56	58	61
3.2.Material	**129**	**135**	**151**	**160**	**175**	**193**
3.3.Treatment Material	**129**	**137**	**159**	**176**	**188**	**200**
3.4.Services	**790**	**1.045**	**1.105**	**1.228**	**1.232**	**1.404**
3.4.1.Services - Others	721	992	1.051	1.174	1.180	1.352
3.4.2.Services-Losses	69	52	53	53	53	53
3.5. Electric Power	**473**	**517**	**590**	**636**	**686**	**730**
3.6. General Expenses	**135**	**147**	**178**	**189**	**201**	**214**
3.6.1. Income from Water Bills	57	59	64	68	73	78
3.6.2. Water Use Costs	17	26	44	48	51	54
3.6.3. Other General Expenses	60	61	71	73	77	82
4. Operating Income (2-3)	3.359	3.310	3.509	3.826	4.228	4.468

5.Fiscal and Corporate Expenses	**645**	**897**	**963**	**1.057**	**1.191**	**1.294**
5.1. Payroll Charges	**154**	**207**	**222**	**244**	**279**	**309**
5.2. IRPJ	**400**	**558**	**596**	**657**	**750**	**832**
5.3.ARSESP - Regularization Fee	**22**	**34**	**34**	**37**	**40**	**43**
5.4 Other Fiscal Expenses	**35**	**65**	**65**	**58**	**60**	**63**
5.5 Agreements/PAES	**34**	**33**	**35**	**36**	**38**	**19**
5.6. Sabesprev	**0**	**0**	**12**	**25**	**26**	**27**
6.Net Operating Income (4-5)	**2.714**	**2.414**	**2.546**	**2.769**	**3.037**	**3.174**
7.Corporate Expenses	**1.166**	**731**	**423**	**509**	**485**	**545**
7.1. Majority Dividends	**561**	**133**	**157**	**189**	**177**	206
7.2 Minority Dividends	**128**	**113**	**157**	**189**	**177**	206
7.3. Income Tax on JSCP	**19**	**5**	**22**	**27**	**25**	29
7.4. Retirement Expenses	**96**	[14]	**25**	**25**	**25**	24
7.4.1.Pensions	108	121	127	133	139	142
7.4.2.Reimbursement of Retired Employees	[11]	[135]	[102]	[108]	[114]	[118]
7.5. Legal Contingencies	**362**	**494**	**85**	**108**	**107**	**111**
8. Net Debt Service	**1.104**	**1.910**	**1.607**	**2.083**	**1.348**	**1.613**
8.1. Amortizations	**626**	**1.316**	**938**	**1.379**	**712**	**973**
8.2. Interest and Commissions	**529**	**612**	**688**	**724**	**656**	**661**
8.3. IRPJ on Interest Remittance Abroad	**5**	**4**	**4**	**4**	**4**	**4**
8.4. Financial Income	[56]	[22]	[23]	[24]	[25]	[26]
9. Own Source (6-7-8)	**444**	[227]	**516**	**177**	**1.204**	**1.017**
10.Financing	**1.029**	**1.727**	**1.720**	**1.306**	**827**	**785**
10.1.Financing	**645**	**792**	**1.013**	**856**	**827**	**785**
10.1.1. Others	**645**	**792**	**703**	**417**	**496**	**503**
10.1.2. JICA	**0**	**0**	**310**	**439**	**331**	**282**
10.1.2.1. Onda Limpa	0	0	300	100	0	0
10.1.2.2. Pro-Billings	0	0	10	20	20	25
10.1.2.3.Losses	0	0	0	319	311	257
10.2. New Borrowing	**384**	**935**	**708**	**450**	**0**	**0**
11. Surplus/Deficit (1+9+10)	**1.669**	**1.844**	**2.337**	**1.967**	**2.140**	**2.092**
12. Investments	**1.280**	**1.761**	**1.861**	**1.823**	**1.818**	**1.795**
12.1.Participation in other Companies	**4**	**0**	**0**	**0**	**0**	**0**
12.2.Financed	**746**	**1.285**	**1.427**	**1.300**	**1.265**	**1.286**
12.2.1.Purely Financed	**403**	**961**	**1.043**	**872**	**838**	**898**
12.2.1.1. Others	**403**	**961**	**733**	**433**	**507**	**616**
12.2.1.2.From Project	**0**	**0**	**310**	**439**	**331**	**282**
Onda Limpa	0	0	300	100	0	0
Pro-Billings	0	0	10	20	20	25
Losses	0	0	0	319	311	257
12.2.2. Sabesp Counterpart	**344**	**324**	**384**	**428**	**427**	**388**
12.2.2.1.Others	**344**	**324**	**294**	**332**	**352**	**318**
12.2.2.2.From Project	**0**	**0**	**90**	**96**	**75**	**70**
Onda Limpa	**0**	**0**	80	20	0	0
Pro-Billings	**0**	**0**	10	20	20	25
Losses	**0**	**0**	0	56	55	45
12.3. Free Funds	**530**	**476**	**434**	**523**	**553**	**509**
13.Closing Balance (11-12)	**388**	**83**	**476**	**144**	**322**	**296**
14. Annual Balanced Related to PMSP	**45**	[17]	[8]	**35**	**31**	**16**
15. Adjusted Cash Balance (13-14)	**344**	**100**	**484**	**109**	**290**	**281**

Chapter 6. Analysis of Stage Financed by JICA

6-1 Evaluation of Components of Actions

Chapter 5 "Analysis of Water Loss Reduction and Energy Efficiency Program" addressed Sabesp fundamentals for action components. This chapter will analyze the contents of actions of JICA Financed Stage from the view of need, efficacy and adequacy of priority of scheduled actions, by making accurate studies of action scope, implementation areas and other UN aspects.

Since 2004, Sabesp has pursuing a better monitoring structure for water loss reduction activities. The PROGRAM general concepts were based on results of activities already completed. This Feasibility Study analyzes the PROGRAM by taking such concepts into consideration.

6-1-1 Parameters for destructive and non-destructive methods for network replacement

1) Concept of replacement of rotten network piping

The table below classifies network per age at Division M. Length of piping laid before 1970, i.e. older than 40 years, amounts to 3,935 km. Non-recorded piping amounts to some 30% of total.

Option for network replacement only for age reasons raises a great concern; however, for piping more than 40 years-old, preventive actions are necessary to prevent deterioration of its water conveyance function.

Table 6-1 – Age of M Division Network

Idade das Redes no Município de São Paulo

Década	Extensão (km)	Percentual (%)
Antes de 1950	341	2
1950 a 1960	1.400	8
1960 a 1970	2.194	12
1970 a 1980	7.027	39
1980 a 1990	2.237	12
1990 a 2000	1.153	6
2000 a 2001	206	1
Sem cadastro	3.647	20
TOTAL	18.205	100

Fonte: PIR, 2002

Percentages in table are for 18,205 km of network of identified age, but the total network length is 28,000 km. Therefore, we may say that such figures are still likely to increase.

Table 6-2 – Length per pipe type and diameter

Diâmetros e Materiais das Redes

Item	Extensão (km)	Diâmetros (mm)				Materiais					
		Até 75	100	125 a 200	Acima 200	Aço	FoFo.	DeFoFo	PVC	PEAD	Cim. Amianto
TOTAL	28.000	18.500	3.000	3.400	3.100	250	18.500	100	8.000	250	900
(%)	100	66	11	12	11	1	65	1	29	1	3

Piping are installed at the proportion shown in Table 6-1 (base year 2002) and Table 6-2 (base year): (2008 source: SIGNOS), classified by diameter and material. It should be highlighted the occurrence of asbestos cement pipes and a high proportion of cast iron pipes with diameter smaller than 75 mm (refer to Table 6-2). Replacement of such pipes should be given priority.

2) Evaluation of distribution network rehabilitation

• Evaluation of planned quantity

This section analyzes the adequacy of network replacement scheduled for JICA Stage.

Out of 28,000 km of network, 4,299 km have been considered to have problems.

Table 6-3 – Length per pipe type and diameter

Diagnóstico para a Reabilitação de Redes de Água - M

Unidade de Negócio	Extensão Total de Redes Implantadas (km)*	Avaliação das Áreas Críticas	
		(km)	%
MC	5.800	1.021	18
MN	5.200	601	12
MS	5.500	908	17
ML	5.800	693	12
MO	5.700	1.076	19
TOTAL	**28.000**	**4.299**	**15**

* Fonte: PIR 2005/2006

The PROGRAM includes a total of 2,399 km of network to be replaced, as shown in the table below.

Table 6-4 – Comparison of replacement extension in JICA Stage and total PROGRAM.

UN	Yen-financed stage	Total PROGRAM
M	708 km (30%)	2,399 km
R	333 km (28%)	1,206 km

Network replacement methodology is based on methods shows in the table below, while technical aspects are based on Sabesp standards NTS 030, NTS 031 and NTS 032, which conform to ABNT – Associação Brasileira de Normas Técnicas standards, by which techniques are assured.

Table 6-5 – Sabesp rehabilitation method

REPLACEMENT OR REINFORCEMENT Non-Destructive Method	Piping replacement (without excavation)
REPLACEMENT OR REINFORCEMENT Destructive Method	Piping replacement (with excavation)

Evaluation of planned quantities

Rehabilitation at JICA Stage will focus on the replacement of water distribution network. Table 6.6 shows the planned and effective network replacement in 2008 (98,000 m and 42,114 m, respectively). Taking into consideration the part not replaced for MS and ML procurement problems, the execution capacity of approximately 100 is given credibility. The annual average annual total length to be implanted during JICA Stage is 247 km, corresponding to 250% of volume of works. However, it is a feasible quantity to ensure the capacity of execution of work as from the transition stage (2009-2010).

Table 6-6 – Network replacement in 2008

	MC	MN	MS	ML	MO	Total
Network replacement	14,926m	14,467m	0	0	12,771m	42,114m

Evaluation of work execution methods

According to Sabesp rehabilitation and renewal programs strengthened as from 2004, general information on M Division activities can be seen in the "Loss Reduction Action Plan". As shown in Table 6-7, rehabilitation is divided into Renewal (Rehabilitation & Coating); Replacement; and Reinforcement with similar or larger diameter. The scope of rehabilitation scheduled for the program is the part of rehabilitation called replacement, which consists of replacing the pipes. The executive rehabilitation method may be classified as destructive and non-destructive.

Table 6-7 – Executive rehabilitation and renewal methods

	Rehabilitation	Epoxy Coating
Non-Destructive Method	Replacement	Directional drilling – Directional Drilling Method
Destructive Method	Rehabilitation	Destructive system

The reason for high-scale adoption of non-destructive methods is the great restriction to large excavations in urban centers. Methods shown in Table 6-7 are concomitantly adopted, by combining their advantages and disadvantages.

In the municipality of São Paulo, the Non-Destructive Method (NDM) is obligatory by Decree no. 46,921, of 01.18.2006. For such a case, recommended replacement is by Dynamic Bursting (Pipebursting Method), a type of NDM.

Left: Drilling Device; Center: introduction of polyethylene pipe; Right: laying completed.

Photo 6-2

3) Evaluation of continuous water meter replacement

Water meters have been replaced more intensively since 2004, but continuous replacement will be adopted as from 2011.

Water meter specifications and rack specifications are detailed in NTS 181, classified as Y(00) to M(11) according to the application.

NTS 181 also provides the specifications of Class B and Class C. Characteristics of most used diameters are shown below.

We would like to point out that, since January 2009, all connections with "Y" or "A" water meters have included an UMA (water measurement unit).

Table 6-8 - Water meter specifications

Nominal Code	00 Y	01 A	02 B	03 C	04 D	05 E	06 F	07 G	08 J	09 K	10 L	11 M
Qm (m^3/h)	1,5	3	5	7	10	20	30	300	1.100	1.800	4.000	6.500
Qn (m^3/h)	0,75	1,5	2,5	3,5	5	10	15	15	30	50	150	250
Class	B	C	C	C	C	C	C	C	C	C	C	C
Age for replacement	8	8	5	5	5	5	5	3	3	3	2	2

The table shows the analysis of contribution of water meter replacement to recovery of micromeasured volume (apparent loss), taking into account a universe of 256,539 replacements. This analysis was made according the Water Meter Management System (SGH). By comparing the micromeasured volume to the volume micromeasured in the previous year, it was confirmed that the micromeasured volume increase by 1.93 m^3 per water meter per month (recovered volume).

Table 6-9 – Volume Recovered by Water Meter Replacements

	Number of water meters replaced	Volume micromeasured before replacement (m^3)	Volume micromeasured after replacement (m^3)	Difference	Recovered volume (m^3/month)
MC	60,758	1,099,980	1,203,564	103,584	1.70
MN	23,538	407,670	462,282,	54,612	2.32
MS	81,376	1,307,748	1,425,810	118,062	1.45
ML	62,290	820,690	957,208	136,518	2.19
MO	28,577	823,798	908,263	82,465	2.89
M (average)	256,539	4,459,885	4,955,127	495,241	1.93

The Technological Research Institute (IPT made an experimental investigation at Sabesp request to determine undermeasurement in low-capacity water meters A and Y installed in the common M list (campaign comprising 390 water meters).

Through SGH, Sabesp made a balance of the situation in M UN water meter center. Such projections are based on 1,255 measurement campaigns carried out and validated in all Metropolitan Business Units. Differences in relation to IPT study are shown in Table 6-10.

Table 6-10 – Undermeasurement Rate

UN	Undermeasurement rate	
	SGH	IPT
MC	13.8%	17.0%
MN	12.0%	17.0%
MS	14.0%	18.0%
ML	16.2%	19.0%
MO	11.6%	16.0%

Source: Analytic Report – Metropolitan Division – 2008.

4) Evaluation of work quality assurance and feasibility of work inspection

A good management and operation of water services cannot dispense with its infrastructure management. The program under analysis provided for the rehabilitation of part of infrastructure (network, branch line and water meter replacement) and implementation of operational management (leakage survey, sectorization, control of irregularities, etc.).

With respect to work execution, the most important aspects include:

- ✓ works executed in a workmanlike manner;
- ✓ works executed on schedule; and
- ✓ adequate, skilled inspection.

- ***Increase of work inspection capacity***

Key words for work inspection capacity are: Proven technique (leadership); Guarantee and Practice. To manage all this, technical skills (human resources) are required. This capacity to inspect works is improved by qualification and training of human resources with the objective of continuously and gradually increasing the technical capacity. .

Sabesp is provided with Procedures and Standards that conform with ABNT, which are the basis of the company's technical capacity.

Table 6-11 – Sabesp Technical Standards (examples)

Nº do Doc.	Data Doc.	Título do Doc.	Palavras Chave
NTS 001	Ago 2001	Obras Lineares Executadas pelo Método Subterrâneo com Anéis Segmentados de Concreto - "Mini Shield"	mini-shield; obra linear; obra subterrânea;
NTS 003	Dez 1997	DBO - Demanda Bioquímica de Oxigênio	Análise físico-química; DBO; Esgoto;
NTS 004	Mai 1997	DQO - Demanda Química de Oxigênio	Análise físico-química; DQO; Esgoto;
NTS 005	Jun 1997	Óleos e Graxas	Análise físico-química; Esgoto; material solúvel em n-hexano; óleos e graxas; Lodo;
NTS 006	Jun 1999	Fenóis - Método colorimétrico para águas residuárias	Água; Análise físico-química; Esgoto; Fenol;
NTS 007	Fev 2003	Fósforo - método colorimétrico com ácido ascórbico para águas residuárias	Análise; Fósforo; Método colorimétrico;
NTS 008	Jun 1999	Turbidez	Turbidez; Água; Análise físico-química;
NTS 009	Ago 2001	Cloreto	Análise química; Cloreto; Água; Esgoto;
NTS 010	Mai 2001	Determinação de Ferro Total: Método da 1,10 Fenantrolina	Ferro; análise;
NTS 011	Fev 2003	Determinação de Alumínio – Método Colorimétrico Eriocromocianina R	Alumínio; Análise; Método colorimétrico;
NTS 012	Dez 2001	Análise de Oxigênio Dissolvido (OD) - Método Eletrométrico	Análise; Método eletrométrico; Oxigênio dissolvido;
NTS 013	Jun 1999	Sólidos	Análise físico-química; Resíduo sólido; Esgoto; Água;
NTS 014	Dez 2005	Coliformes Totais e Termotolerantes - Método de membrana filtrante	Coliforme; coliformes; contagem; determinação; Membrana filtrante;

6-2 Evaluation under the 5 Criteria for Yen Loans

(1) Importance:

For reasons stated below, JICA Stage can be considered highly importance as a Yen-financed project.

- Utmost objective The objective of this project is in line with Brazilian and São Paulo State development policies.

  The population of the State of São Paulo amounts to 40 million inhabitants, which account for 20% of Brazilian population. Water supply to that growing population is becoming a serious problem. To make the situation worse, exploring new water sources has proved difficult because of the respective environmental problems and unavailability of good sources in the proximities of São Paulo Metropolitan Region.

  As such, minimizing leakages in Sabesp networks that serve 23 million inhabitants in the State of São Paulo, and increasing the operational management capacity in water supply facilities will open perspectives for the efficient use and preservation of limited water resources in the State of São

Paulo.

- Compatibility with priority topics of Japanese assistance and JICA country assistance program.

Japanese ODA medium-term policy establishes the development of human resources and support to knowledge and actions at global environmental level (environmental preservation, among others) as priority matters. Environment sector is a basic topic of Japanese diplomacy. In addition, the Country Project Implementation Program (2002) establishes as priority areas the regional promotion and social development for environmental preservation and inequality correction. Moreover, in JICA Topic Guidelines (preservation of natural environments), the increase of natural resource management capacity by local community and preservation of high-biodiversity regions and ecosystems are considered priority issues. The objective of PROGRAM, i.e., the efficient use and preservation of water resources, is included in priority areas and aspects referred to above.

- The following basic guidelines are mentioned in JICA Country Project Implementation Program (2002).

Basic guidelines have been established in this program based on:

1) Different levels of cooperation and interchanges between those that implement diverse developments, especially the private sector, will result in closer bilateral economic relationship and gains for both countries (Benefit for both countries).
2) (Eliminating poverty and inequalities is a major challenge in Brazil. In health, medical care and other areas, objective actions have been adopted by the country and civil society, which support development. Japan has also learnt cooperation lessons from those sectors involved with the population and has tried, in turn, to transmit the idea of valorizing justice. If such initiatives could be disclosed in and out of the country as model programs based on values shared by both countries, this would result in joint international contribution of both countries (benefit for both countries; international benefit).
3) Global issues, such as environmental preservation, food production and other are important issues that the international community should tackle for their great importance for mankind (international benefit.
4) Transfer and diffusion of cooperation results to Portuguese and Spanish speaking countries could have even greater effects (international benefit.

- Alignment with other projects (assistance by Japan and other donors).

With respect to Japanese assistance, the Technical Cooperation Project for Losses (EFICAZ Project) is in line with the objectives of the PROGRAM. Inheriting and developing the results of EFICAZ Project may bring synergy. Promoting the integration of financing cooperation and technical cooperation is in line with Japanese ODA policy.

With respect to assistance by other donors, there are in the State of São Paulo other projects financed by the World Bank, IDB and other institutions as previously mentioned. The PROGRAM

is also in line with projects of other donors.

- High priority in Sabesp administrative policy

  The PROGRAM occupies an outstanding position in Sabesp long-term plan.

- Japanese technology

  Japanese technology evidenced in EFICAZ Project has been well evaluated. Technical knowledge transferred by that project has been used in different parts of the process of preparation of the Corporate Water Loss Program. It is concluded that Yen loan is highly important for the PROGRAM in terms of loss management, for which Japan has a more advanced technology.

(2) Efficacy:

JICA Stage under the PROGRAM is considered of high efficacy for the following reasons:

- Target of JICA Stage is "to increase Sabesp capacity in terms of water loss management." Indicators of target achievement level are shown below. Both target and indicators at this stage are clear and adequate.

  ① Up to 2013, invoicing loss rate will be reduced to 20% (IPF).

  ②Up to 2013, water loss per connection indicator will be reduced to 307 liters/connection x day (IPDt).

- JICA Stage corresponds to the first stage of PROGRAM and plays a significant role for the solution of priority issues related to Sabesp water loss management.

(3) Efficiency:

JICA Stage may achieve an efficient implementation for the following reasons:

- Individual plans to meet JICA Stage targets have been proposed according to the field reality of each UN.
- During 2009-2010 preparation period, the water loss information management system will be established, which will provide the head office with a structure that will make the operational management of JICA Stage implementation easier.
- In addition to expected EFICAZ projects results in connection with technical and management staff capacity building, the manager is at contracting stage. JICA Stage implementation is likely to provide Sabesp with a sustainable water supply operation by acquiring the ability to identify the water loss causes, analyze and implement effective actions. JICA Stage approach may be considered adequate and efficient.

(4) Impact: JICA Stage impact may be considered as follows:

- Water loss is an important managerial issue. The PROGRAM will take 11 years to solve this problem. The scope of participation of this PROGRAM in the investment plan will allow the size of Program impact on Sabesp management as a whole to be recognized. This Program should also be

considered as part of management efficiency process. PROGRAM impact on Sabesp business sustainability shall not be small.

- Synergy with EFICAZ Project results is expected with respect to losses.
- JICA Stage, which corresponds to the 1st PROGRAM Stage, is expected to exert great impacts on the following stages.
- Actions against illegal connections in slums will have social impacts.

(5) Sustainability:

There are not great problems with respect to the perspective of JICA Stage autonomy and sustainability.

- Sabesp is a great organization that employs some 16,000 employees. Implementation structure is constituted of skilled staff.
- Sabesp is a corporation listed in São Paulo and New York Stock Exchange. Its management is stable and its foreign borrowing is a stable source of funds. Investments in new businesses are supported by Sabesp. It is anticipated that, after the current PROGRAM (2009-2019) completion, maintenance resources for operational management will be ensured, and the implementation of loss control activities will continue.

(6) Remaining Issues

To allow JICA Stage to be significant as a Yen-financed activity, the following requirements should be met:

1) Establishing scopes to clearly indicate the generation of results and specify the implementation schedule.
2) Creating an implementation framework to allow JICA to manage agreements and the progress of its stage.
3) Having financial importance.

With respect to ①, the designation of the original 1st Stage of PROGRAM as *transition stage* made the selection of JICA Stage scope possible according to their priority order. Likewise, it solved the execution schedule problem, which originally provided for JICA Stage to start after the completion of 1st Stage. What should be considered now it the good integration between JICA Stage and the subsequent stages. The several activities scheduled for JICA Stage will not be completed all at the same time. The current Sabesp PROGRAM provides for a stage to start when the previous stage is fully completed. Therefore, it is necessary to consider, since the beginning, the general schedule of PROGRAM, as some activities will be subject to action peculiarities, and some activities will have their continuity emphasized.

In relation to ② above, the implementation framework plan establishes that works are UN competence, and the general coordination of PROGRAM is incumbent on TO Superintendence. Hiring a manager for general management, schedule management and financial resource management shall be TO responsibility, while hiring to inspect the works shall be UN responsibility, should this need be identified. The issue likely to originate from this scheme is the possibility of reporting adequately to JICA the progress of UN works and quality control (work execution). The loan alone does not match the form of ODA Yen financing. On the other hand, inspection of measurements of all agreements by TO is in practice a difficult task, as the PROGRAM involves all UNs in the State of São Paulo. The solution for this problem is building a best structure possible, by using the Loss Management System to be established at the transition stage;

With regard to ③, the provisions of item 6.5 should be followed.

(7) Conclusion

Upon analyzing the PROGRAM as a whole, no aspects were determined to be an obstacle for Yen financing.

Chapter 7. Recommendation for Stage Financed by JICA

This Chapter addresses the proposed actions to be taken for the feasibility of Yen loan for the PROGRAM during JICA Stage.

7-1 Implantation of Loss Management System - SGP

An issue of Sabesp water loss reduction activities is the insufficient "Basic Actions". Sabesp is provided with a great volume of information in its database, which are useful for loss control actions. However, using that information has some practicability problem, that is, mapping (network diagram), distributed volume and micromeasured volume are not organized per distribution sectors, data on leakage occurrences and customers' complaints are not related to water loss control actions (data organization has been improving); there are some constraints to retrieve from the database information on piping (type, diameter, year of installation, length).
In addition to the possibility of plotting thematic maps using SIGNOS system, it is not possible yet to prepare maps reflecting the action plan to control water losses.

Sabesp intends to implement a new water loss management constituted of Loss Management System – SGP and Integrated Planning Management System – SPI, which are scheduled to be developed during the transition period, to use the interfaces with corporate systems in place (SIGNOS, SIGAO, CSI, SGH, SGE, SGO, SGL, SRH and NOVA SCOA); Also in 2009, Sabesp with outsource, using its own funds, a firm to implant such systems within a period of 30 months.

- Implantation of Loss Management System - SGP

It will include the following items:

- Implantation of a corporate system to manage the results of loss reduction actions;
- Unification of data collection sources;
- Standardization of layout and contents of managerial reports on loss control and reduction;
- Fast and consistent sharing of information among the several UNs and Divisions;
- Training;
- Specification of hardware and software to support SGP;
- Support to loss diagnosis in each SYSTEM (physical controil unit characterized by Supply Systems (Metropolitan Division – M) and municipalities (Regional System Division – R);
- Support to prioritization of actions in each SYSTEM.

- Integrated Planning Management System - SPI

It will include the following items:

- Support to review of integrated planning process;
- Support to survey of requirements for development of an information system for Sabesp integrated planning management.
- Implantation of corporate information system in a WEB and graphic environment, to support the management of the project life cycle (investments or expenditures), from the design to the confirmation of expected results, and support to project development follow-up.
- Development of interfaces and data integration with corporate budget systems, procurements, contracts, measurements, loss management, human resources and Project Management System (EPM);
- Fast sharing of information for MS Office environment.
- Provision of simulation environment, planning scenarios, schedule and reschedule;
- Implantation of a parametrization tool to make module adjustment easier, support changes to organizational framework and general tables, by keeping the history of information and operations, with the objective of meeting specific needs of Divisions, Business Units and Superintendence.

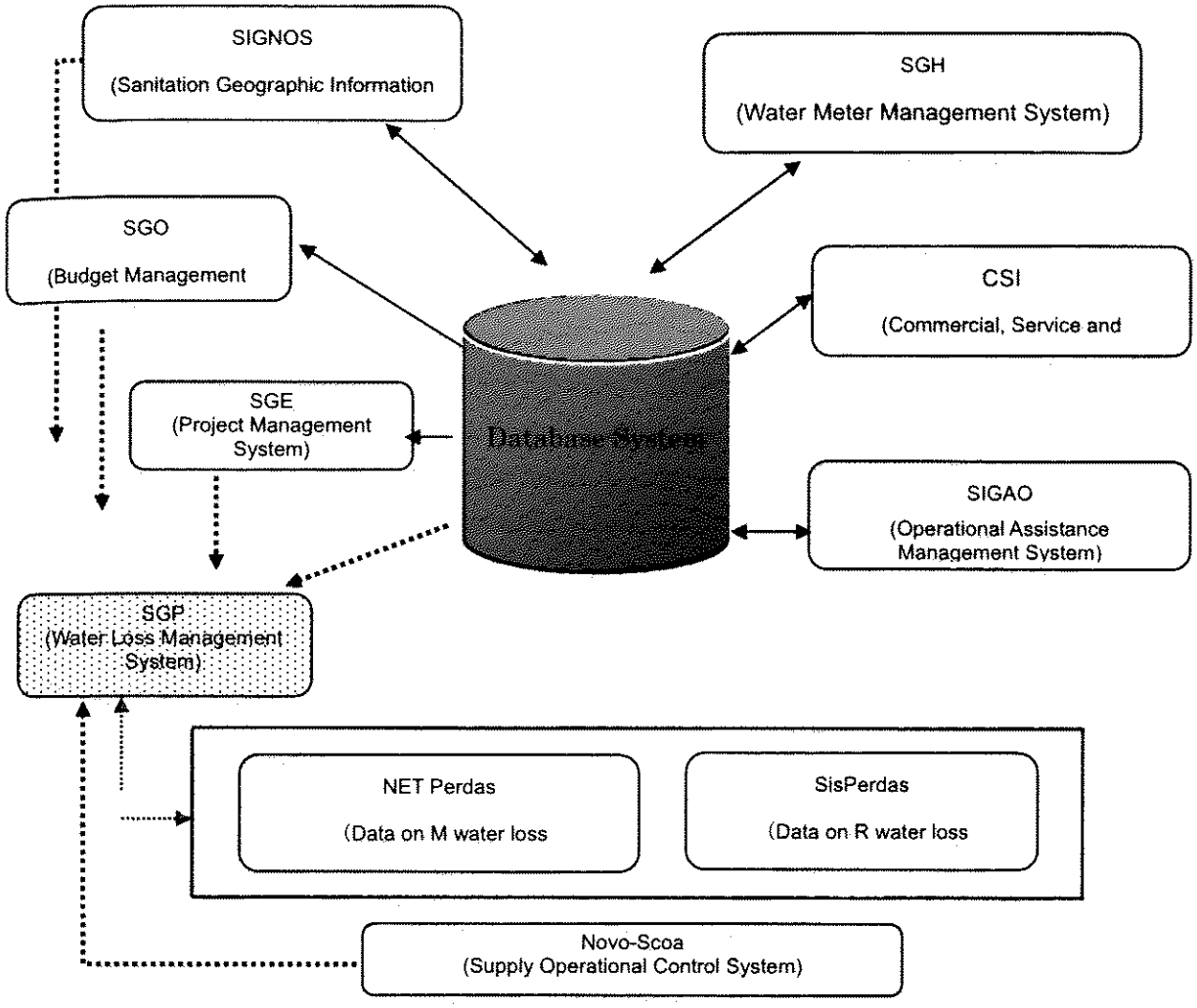


Figure 7-1 – Sabesp Information Management System

7-2 Integration with Eficaz Project

Most concerning issues related to the PROGRAM may be summarized into:

- possibility of implanting the works without compromising their quality; and
- possibility of full inspection of works by Sabesp employees and/or consulting firms hired for that purpose.

According to a diagnosis made and submitted by Sabesp, the main causes of leakages are:

1) pipe quality problem;
2) branch line construction problem;
3) work quality problem;
4) problem of quality of workmanship used for execution of work; and
5) external pipe conditions (installation depth, soil, water table level, traffic volume, etc).

Eficaz Project targets include: qualification of human resources and loss management technology transfer through courses and OJT (On-the-Job Training). It was also confirmed that capacity building under Eficaz Project to improve the contractors' work execution capacity, and Sabesp employees' work inspection capacity would be used by the PROGRAM, which shows full adherence to primary requirements for good progress and development of the Corporate Loss Reduction Program.

In parallel, Eficaz Project does not limit to providing training on work execution and inspection methodology. Based on the assumption that loss control is a synonym of integrated water supply management, Eficaz Project aims to disseminate in all UNs the tools and expertise related to water loss control. UNs have submitted their needs translated into actions to reduce and control losses, and the PROGRAM is the consolidation of such actions. Later, over the 2009-2010 transition stage, UNs will use the expertise obtained from Eficaz Project to improve the action plans, which will be the next step, combined with the importance of having continuous maintenance and management actions in place, and the results obtained from water loss reduction actions. Such items have been confirmed at M/M of JICA Monitoring Mission in the period of May 13-28 2009. Such evidences will allow an integrated development of activities under Eficaz Project and during JICA Stage. It could be said that the good performance of activities under Eficaz Project during the transition stage is the key for JICA Stage success.

An effective example of that integration is "work quality". According to Brazilian standards, as the work volume increases, its quality tends to decrease. JICA F/S Mission regards as an important issue to be addressed the adoption of means that would allow all 15 UNs to make work quality uniform and standardize work inspection. This issue arises from the insufficient skilled labor in contractors, insufficient number of Sabesp employees engaged in work inspection; and lack of standardization of work inspection manuals. Preparation of manuals (practical work execution manuals used in work sites) and training in work execution and inspection methodology for Sabesp employees should be made under Eficaz Project.

It could be said that maintaining the work quality will depend greatly of awareness programs adopted by private companies. However, there are not currently in Brazil (including Sabesp) training courses, technical seminars, technical guidance and other actions to promote the capacity building of human resources or the companies' technological expertise focused on work execution. Preparation for the effective start of PROGRAM activities in 2011 requires the implantation, prior to that start, of a system that would make training feasible implement it.

Main aspects of work inspection capacity includes: technical skills, management and practice. Work inspection requires human resources provided with all such factors. This capacity to inspect works is obtained and improved by qualifying the human resources, training and OJT, with the objective of continuously and gradually increasing the technical skills.

A technical cooperation for loss management and training courses are being started under Eficaz Project. A greater integration with Eficaz Project should be promoted to strengthen work execution and inspection skills, involving public and private organizations.

7-3 Sustainable Maintenance Improvement

(1) Sustainability of maintenance management services

The effective start of water loss reduction actions financed by Sabesp own funds took place in 2004. Based on results of completed activities, high-value investments have been allocated to the PROGRAM. However, controlling losses means to manage water supply in an integrated manner, in such a way that the related actions will not cease after the PROGRAM completion.

The PROGRAM should be structured to promote the periodic implementation of leakage surveys, planned piping replacements (based on time of use/operation), and scheduled water meter replacements every 8 years, among others. In addition, the PROGRAM implementation should also include activities focused on maintaining and expanding the effects after the completion, such as: determination of Sabesp parameters; storage of data on replaced networks and branch lines; enhancement of leakage detection techniques; improvement of work execution methodology; training in work execution techniques for contractors; training in work inspection for Sabesp staff; etc.

(2) Monitoring

Additionally, many activities will be performed simultaneously during the PROGRAM implementation, which will require periodic evidence of results generated by such activities, to indicate how and how much each activity contributed to reduce water loss, and then use that information when establishing new indicators/adjusting indicators of results of implemented actions.

(3) Chronological monitoring of water loss reduction rate

Installation of a total number of 803 macrometers is scheduled under the PROGRAM (282 during JICA Stage). Together with the implantation of macromeasurement equipment, 219 sectors and 1,591 DMCs will be implanted.

At the PROGRAM completion, loss situation will be identified by DMC, which provides a better distribution network monitoring, in addition to the effective pressure and outflow control. However, JICA F/S Mission wants that resource to be installed and used before 2019.

IPDt, its major indicator, calculates the percentage of water loss volume by comparing the ,micromeasured volume (consumed volume) with to the distributed volume. However, it is not possible to say that the level of network deterioration may be expressed only by that indicator.

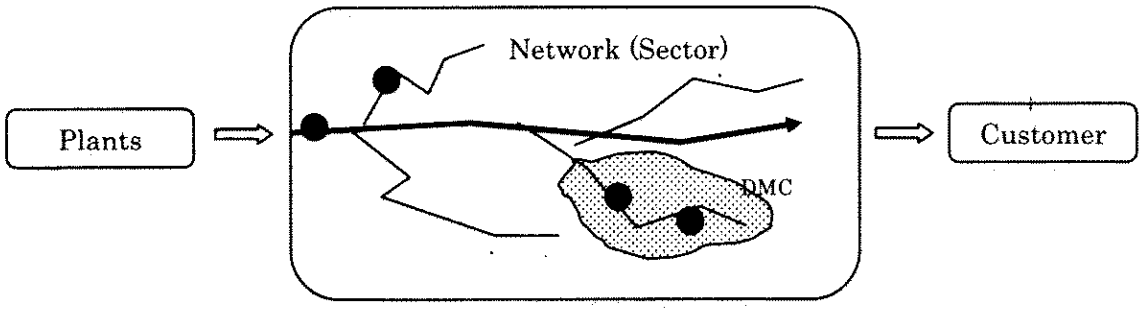


Figure 7-2 – Illustrative drawing of sector relation between network and DMC

The figure above shows the relation between the installation of flow macrometers (indicated as ●), sector and DMC. It is assumed that all 803 macrometers will be installed basically to measure the sectors. JICA F/S Mission understands that loss reduction activities should be implemented by using, without prejudice, volume-monitoring data collected by installed macrometers and other means, and confirmed the progress of 11 years of PROGRAM and the results obtained.

Several data collection methods may be envisaged, but it is desirable that data are collected and analyzed by a standard cost-effective procedure.

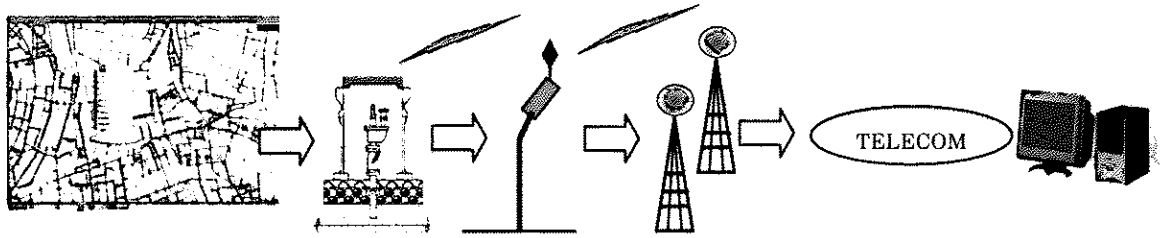


Figure 7-3 – Image of computer-based network monitoring

The preliminary action plan related to loss reduction actions scheduled to be take on a yearly basis or in subsequent stages may also establish in the selected points, as necessary, means to produce impacts in reduction rate (total reduction volume), including the review of action plan added of bold adjustments and final corrections.

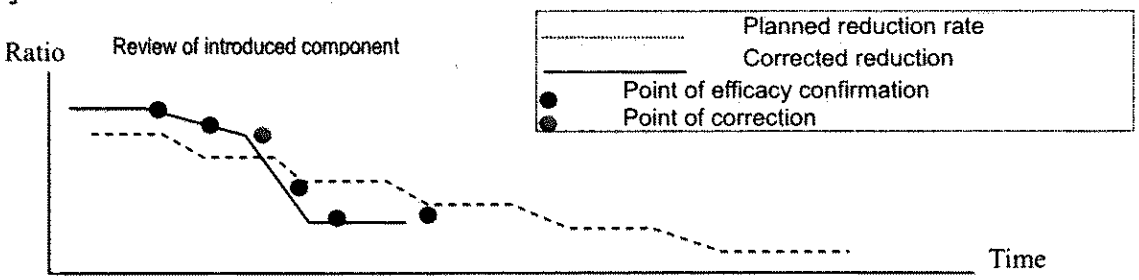


Figure 7.4 – Action plan reconstruction by monitoring the reduction rate and volume

(4) Program financial management

The Study Mission suggests the implantation of an accounting management system for water loss management. It is desirable that this system be completed by the start of JICA Stage, in 2011. Suggestion reasons are listed below.

The financial adequacy of PROGRAM was evaluated by the Internal Rate of Return (IRR) and other rates, but that is an estimated calculation based on some assumptions, such as the sale of water volume recovered from loss control. Thereby, it is necessary to monitor the type of variation occurring in figures related to real revenues and financial expenses.

Monitoring the PROGRAM results on a quarterly basis will enable the water loss management. Companies listed in New York Stork Exchange are required to provide quarterly financial reports. Because of the PROGRAM importance, the submission of its financial reports cannot be disregarded.

The implantation of the Water Loss Management System is scheduled for the preliminary stage of 2009-2010, based on existing data. By inserting the financial data in that system, it will be possible to make it able to manage the losses at global level. As the procedure to hire the Loss Management System manager has already started, it may not be possible to include the financial data. In this case, the appropriate solution is through the Eficaz Project.

(5) Analysis and optimization of water distribution through monitoring data

It is understood that it is critical to have in place an effective methodology for use of collected data (continuous and transitory data at each sector and DMC level.

1) Network evaluation by the approximate calculation of loss volume (leakage) through Qmn (minimum night flow):
   Flow data obtained by macrometers installed in selected intake points, in particular the minimum night flow (Qmn), become an indicator of total loss evaluation.

   In this regard, Eficaz Project has analyzed the Qmn and Qd (leakage volume from direct measurement) ratio, and through some sampling activities the multivariate analysis equation will be deducted to calculate the approximate Qd value based on Qmn.

2) Hydraulic simulation for implantation of supply sectors and DMCs (evaluation for project execution):
   Flow data obtained from macrometers installed for sectorization contain more than 70% of information on water supply. If it is possible to collect flow data from a certain number of trunk lines, it will be possible to evaluate beforehand whether the sector or DMC to be implanted is adequate.

In addition, for the Priority Group, collecting in advance the flow data of provisory sectors and analyzing the network will produce data that will serve as inputs for project specifications, such as: piping reinforcement for variation of demanded water volume; level of valve opening; booster capacity; VRP configuration; and others.

The figures below show the water pressure analysis per diameter of existing piping, made by EPANET.

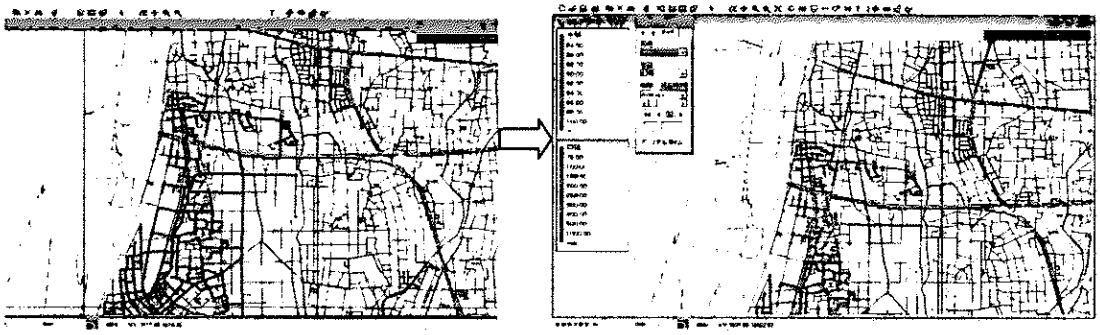


Figure 7-5 – Network prior to analysis (left) and display of pressure analysis (right)

Chapter 8. Preliminary Project Guidelines

8-1 Preliminary Project Guidelines for JICA Stage

In this Chapter, we will describe the methodology used for the design of the PROGRAM, which was based on Sabesp Technical Standards – NTS, Procedure for Service Execution and Technical Manual already available at Sabesp.

The method of work adopted by the Feasibility Study Mission, hereinafter referred to as F/S Mission, was based on the understanding or Sabesp guidelines and methodology study, rather than the imposition of new guidelines. As a result of that work, we have concluded that JICA F/S Mission and Sabesp share the same understanding of the matter, what will be shown in this report, including the analysis of actions related to the PROGRAM.

In addition, F/S Mission discussed with all Business Units – Sabesp UNs – how techniques and methodologies applied in Japan could be incorporated to the whole Sabesp Water Distribution process, to allow Sabesp to achieve through the PROGRAM the level of Water Distribution efficiency seen in Japan, taking into account, obviously, the different technical-operational development in both countries.

The major aspects are listed below:

- Sabesp disposes of adequate guidelines and procedures; however, they do not seem to be fully considered during the execution of services and works.
- Each UN is responsible for the design of projects according to Sabesp guidelines.
- Contributions to the Project for Technical Cooperation for Water Loss Control and Reduction, hereinafter referred to as Eficaz Project, are being incorporated to procedures for execution of Sabesp works and services.

8-2 Sabesp Internal Standard Project Guidelines

8-2-1 Sabesp Internal Guidelines

As mentioned previously, Sabesp have its own guidelines in place (NTS), which establish standards for projects, material, equipment, and procedures for execution of water and sewerage service and works. This material is used to ensure the quality and standardization of services and works in Sabesp.

All NTS are prepared in conformity with the Brazilian Standards (NBR) established by Associação Brasileira de Normas Técnicas (Brazilian Association of Technical Standards) (ABNT), the body responsible for technical standardization in Brazil. Such standards correspond to US ANSI standards,

German DIN standards, and Japan JIS standards.

Currently, NTS are controlled by sequential numbering, which today runs from 001 to 284. Although there is no numbered classification for specific groups, it is possible to look up all existing NTS on a particular matter, such as, for example, a matter of specific interest. In addition, all NTS are continuously updated to reflect eventual technological developments.

8-2-2 NTS related to networks and branch lines

We list below the NTS available for project, material and execution of network and branch line works. Further details can be found in the Supporting Report.

Table 8-1 – List of NTS related to networks and branch lines

Number	Title
NTS 024	Design of Projects - Water Distribution Networks
NTS 177	DE-20 and DE-32 plastic intake collar with metallic insertion for building branch lines
NTS 181	Specification of building water branch line and water meter
NTS 182	Metallic intake collar for DE-20 and DE-32 polyethylene building branch lines derived from cast iron water distribution network up to ND 150
NTS 189	Projects for PE-80 or PE-100 polyethylene distribution networks, pipelines and sewerage networks
NTS 190	Installation of PE-80 or PE-100 polyethylene distribution networks, pipelines and sewerage networks.

8-2-3 Other Documents

In addition to NTS, Sabesp is provided with the "Procedure for Execution of Services and Works" and "Standardization of Metropolitan Maintenance Procedure – PPM", the latter of which is applied to operational units reporting to the Metropolitan Department.

With respect to such documents, it is possible to say that they are not classified by target public, such as managers, inspectors, workers or contractors. In spite of the high number of documents available, there are some deficiencies in their application to services and works. After analyzing the possible causes, we have concluded that this seems to occur because the prevailing language is inadequate for those persons responsible for the execution of services and works. In addition, there is no training for those persons, to ensure that such procedures are fully considered at the execution of services and works.

This way, two major products of Eficaz Project, i.e., the preparation of Standard Procedures for execution and inspection of services and works, and the structuring of the capacity building system should be incorporated to the PROGRAM before the start of JICA Stage, to ensure the control and technical quality of execution of services and works.

8-3 Project Concept for the Whole Group

Actions for the Whole Group are set out in Table 8-4. Such actions contribute to optimization and enhancement of efficiency levels of water distribution systems.

Table 8-2 – Actions for the Whole Group (Part 1)

Actions to Control Real Losses			
No.	**Component**	**Project Concept**	
A 1-1	Branch line replacement	Preventive action + Corrective action	Replacement of leaking branch line
A 1-1	Repair for survey of non-visible leakage (branch line replacement)	Corrective action, planned service	Prevention of leakage backsliding based on the history of leakage and number of occurrences.
A 2	Non-Visible Leakage Survey	Corrective action, planned service	Annual survey frequency giving priority to areas with high leakage volume.
A 3-1	Repair of visible leakage in networks	Corrective action, inspection service	Prevention of secondary accident, acceleration of inspection service
A 3-2	Repair for survey of non-visible leakage (networks)	Corrective action, planned service	Prevention of leakage backsliding based on the history of leakage and number of occurrences.
A 4-3	DMC – Measurement and Control District	Preventive action	Control of wasted volume and more efficient active leakage control, combined with leakage survey action
A 4-5	Slums (closing of primary supply ring)	Basic action	Study to control areas where Sabesp operation is impracticable for regularization of water connections
A 5	Supply of material and equipment related to actions against losses	Support to related services	NA

Within the category of Actions to Control Real Losses, actions applicable to the Whole Group include: replacement of branch lines upon the occurrence of leakages (corrective action), survey of non-visible leakages, repair of leakages in networks, and implantation of Measurement and Control Districts – DMC, which consists of subdividing the systems and implanting a measurement that would allow a better distribution control and support the active leakage management.

In addition, in big cities where there are many problems of irregular housing (slums) and Sabesp faces great constraints to regularize water connections, there is a pilot project for implantation of distribution rings to surround the slums and ensure pressure control to reduce losses.

Table 8-3 – Actions for the Whole Group (Part 2)

Actions to Control Apparent Losses			
No.	**Component**	**Project Concept**	
B 1-1	Replacement of high-capacity water meter	Basic action	Analysis of customers' consumption profile, selection and redesign of water meters to reduce undermeasurement losses.
B 1-2	Replacement of low-capacity water meter	Basic action	
B 2-1	Inspection of inactive connection	Basic action	Control of irregular use of water supply through inactive connections included in the commercial records.
B 2-2	Inspection of illegal connection (fraud)	Adequate operational service action	Reduction of illegal connections, history of rate of illegal connections.
B 2-2	UMA installation	Adequate control and maintenance action	Inhibition of occurrence of frauds by recidivist customers.
B 2-3	Connection installation in regularized slums	Social action	Network and branch-line management and laying in regularized areas.
B 3	Personal Record Update	Basic action	Periodic update of data on water supply service

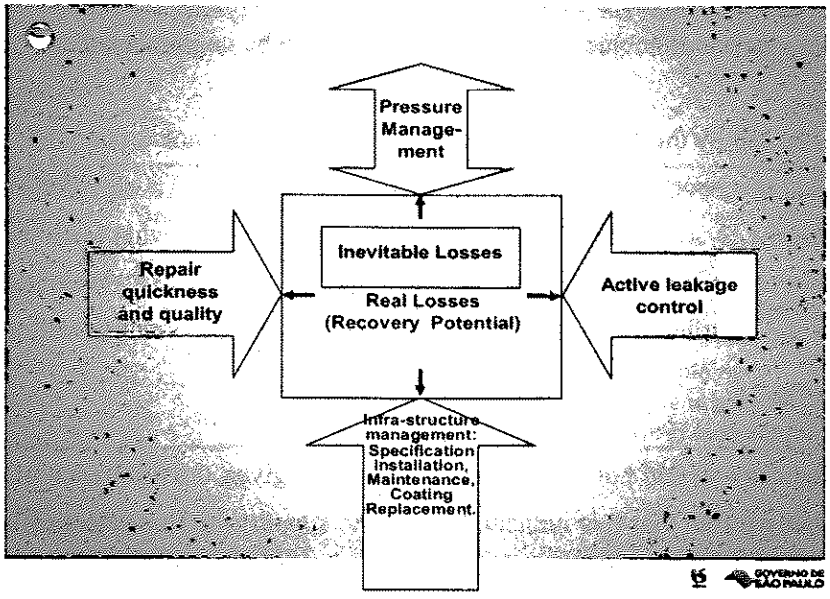
Within the category of Actions to Control Apparent Losses, most actions listed in the table above relates to consumer service and information control, which are a major aspect of the project, that is, commercial actions.

With respect to the selection of water meters to be replaced, the Hydrometry Management System – SGH is adopted, which enables the preparation of an efficient water meter replacement plan.

Table 8-4 – Actions for the Whole Group (Part 3)

Losses • Leakage Control • Management			
No.	**Component**	**Project Concept**	
C 1	Installation of macrometers	Basic action	The whole supply system should be micromeasured to ensure control.
C 2	Macrometer calibration	Basic action	To ensure the full operation of measurement equipment.
C 3	Training	Action of technique transfer and improvement	Increase of external and internal training time and increase of technical skills
C 4	Socio-educative action for dwellers	Action to improve water supply service and Social Action	Consumers' satisfaction, socio-educative activity for correct water use
C 5	Consulting costs		General management support service

8-4 Methodology for PROGRAM Structuring



8-4-1 Actions Included in Priority System Group

Basically, control of real water losses (physical losses) comprises the following actions:

- Pressure management, subdivided into sectorization, installation of Pressure Regulating Valve, VRP and Booster;
- Infrastructure management, including network (and branch line) replacement and branch line replacement;
- Active leakage control through the survey of non-visible leakages;
- Repair quickness to ensure a quality service.

Given the high cost of pressure and infrastructure management actions, Sabesp has not allocated significantly funds to such actions in its previous loss control plans, even aware that the results of such actions provide more longstanding effects.

The PROGRAM sought to highlight the pressure management and control action to tackle real water losses; consequently, replacement of networks and branch lines become an indispensable action to ensure a quality supply at lower pressures. Thus, pressure management action through system sectorization will lead to other actions, such as the installation of a Booster to allow a relatively high pressure in a smaller area and the respective control, and, alternatively, the installation of a VRP to minimize as much as possible the work pressure level without prejudice to supply.

8-4-2 Selection of Priority System Group

To select the Priority System Group, the Daily Loss-per-Connection Rate (IPDt) was taken as a reference, and among the 300 existing systems (number that changes every year, depending on the concession agreement at M and R Superintendence), 158 systems were selected, where, in addition to

physical and apparent water loss control actions to be applied to all Sabesp systems, pressure management actions (sectorization, installation of VRP and Booster) and infrastructure management actions (network replacement, including branch lines) will also be implemented.

In service reports issued by the Metropolitan Division (M), it can be noted that 93.5% of leakages out of a universe of 900 thousand leakages per year occur in branch lines. Those 158 distribution systems comprising the Priority System Group account for 80% of lost volume, what leads us to conclude that some 75% of losses occur in branch lines in the Priority System Group. This way, upon implementing actions to allow the distribution pressure to be reduced, that lost volume will tend to decrease significantly.

In general, this indicator would not be the most appropriate, given the difference of density in water supply systems, but we find that this indicator is valid to support the first selection stage, because of the characteristics of Sabesp distribution networks.

In addition to the selection of actions for the Priority System Group, actions for all other water distribution systems have also been established, having that group been given the name of Whole Group, which includes more than 500 existing systems. In that group, actions to control loss reduction can be seen everywhere, such as basic actions, corrective actions, preventive actions, water distribution control actions, and socioeconomic actions.

Table 8-5 shows the distribution of System Group at UN level:

Table 8-5 – Figures of Priority System Group and Whole Group

Business Unit	Priority Group	Whole Group
MC	21	29
ML	15	20
MN	19	30
MO	32	44
MS	27	49
Subtotal of Metropolitan Division	**114**	**172**
RA	5	48
RB	2	62
RG	1	29
RJ	9	12
RM	15	35
RN	1	4
RR	0	23
RS	6	10
RT	0	83
RV	5	24
Subtotal of Regional Superintendence	**44**	**330**
TOTAL	**158**	**502**

Source: Prepared by F/S Mission, base don data provided by Sabesp

8-4-3 Project Concept for Priority Group

After establishing the Priority System Group, each UN established criteria to determine the exact area for implantation of each action, taking into account the regional, social and water-related characteristics:

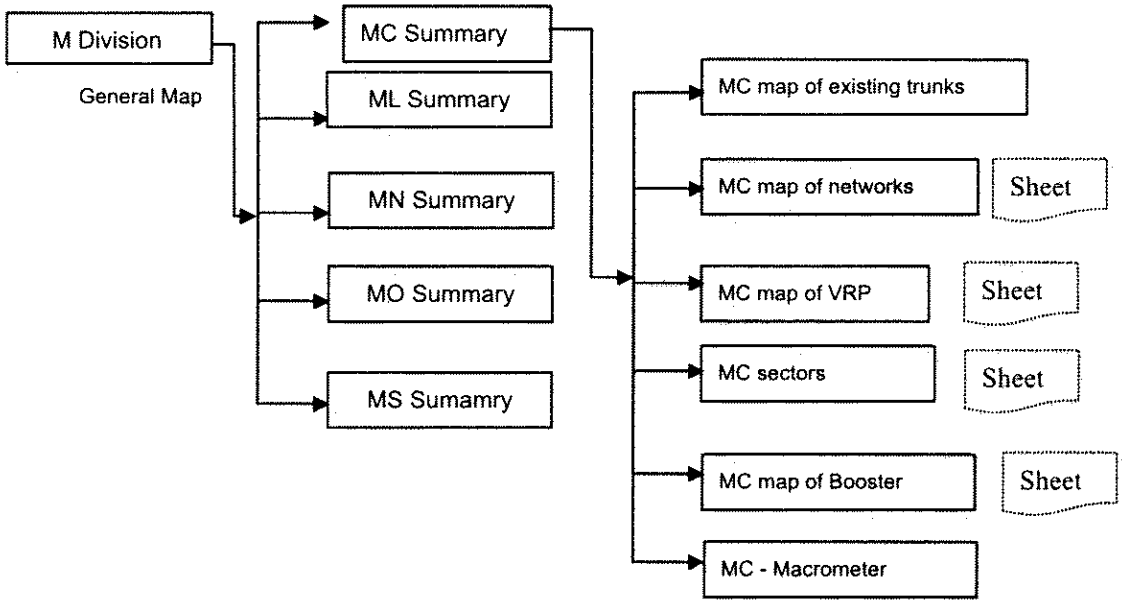
Table 8-6 – PROGRAM Components for the Priority Group

Name of Component	Selection Criterion
Network replacement (including branch lines).	1) Rotten pipes (age of pipes, uncoated pipes, material – ACP); 2) History of leakages (occurrence of leakages in networks and bran lines); 3) Prevention of water quality decrease (emergence of turbid waters) – (users' complaints); 4) Lack of water pressure (users' complaints); 5) Leveling of high and low pressures in network, even supply; 6) Consolidation of control and distribution readiness.
Installation of pressure reduction valve	
Sectorization	
Installation of Booster	

8-5 Map Handling

(1) Structure of preliminary maps (BASIC PROJECT)

Below is the Report structure of preliminary maps; for illustration, we will use the Metropolitan Division – M.



MC Summary Map: indicates MC networks and reservoirs

MC Map of existing trunk lines: indicate MC trunk lines (pipelines)

(2) Specifications of preliminary maps

Contents of preliminary maps were determined by "NTS 024: "Plan, project and process for Sabesp water distribution networks". Items shown include: indication of networks to be rearranged, indication of locations and/or areas selected for implantation of sectors, boosters, pressure regulating valves and macrometer. The basic preliminary map structure follows the specifications below:

Table 8-7 – Preliminary map structure

	Item	Specification
1	Reduced scale	Based on 1/10,000
2	Summary Map:	Highlight of priority action area
3	Networks (outline)	Types of pipe, diameter, length, name of streets
4	Location of VRP	Diameter and quantity of installed pipes
5	Sectorization	Scope of sectorization, number of connections, network length
6	Location of Booster	Diameter and quantity of installed pipes
Indication: information in No. 3 through No. 6 will be prepared by layers, but printout and indication will be made in overlapping layers. Electronic style: AUTO CAD Determination/indication of properties crossed by pipelines: preparation and determination using EXCEL database (DB), etc., or considered as part of the layer.		

Chapter 9 Preliminary Project

In this chapter, we address the preliminary projects of PROGRAM components during JICA Stage, according to the "Preliminary Project Guidelines" established in the previous chapter. The preliminary project was designed by all 16 Business Units and is divided into 5 parts, namely: loss status, characteristics and main problems, general considerations of JICA Stage actions, Corporate Water Loss Reduction Program, and drawings of each Business Unit project.

JICA F/S Mission visited all Business Units over a period of 3 weeks in July-August 2009, and collected the information related to the PROGRAM. The Business Units included in visits are listed below.

Table 9-1 - Business Unit

Business Unit (UN)			
M	**Metropolitan**	**R**	**Regional**
MA	**Water Producer**	**RA**	**Alto Paranapanema**
MC	**Central**	**RB**	**Baixo Paranapanema**
ML	**East**	**RG**	**Pardo and Grande**
MN	**North**	**RJ**	**Capivari / Jundiaí**
MO	**West**	**RM**	**Médio Tietê**
MS	**South**	**RN**	**North Coast**
		RR	**Vale do Ribeira**
		RS	**Baixada Santista**
		RT	**Baixo Tietê and Grande**
		RV	**Vale do Paraíba**

This report makes a brief description of the current status of Losses and Problems in each Business Unit. Further details are available in the "Supporting Report".

9-1 Situation of Business Unit Losses

It is important to stress that, because to local characteristics, there is a significant difference between Business Units (UN) attached to the Metropolitan Division (M) and those attached to Regional System Division (R). This is mainly because M UNs are located in São Paulo Metropolitan Region, where water supply system is old and roads have a heavy traffic of vehicles. In addition, there are a great number of slums and a far-reaching population that always has an abnormal size.

All Metropolitan Business Units (MC – ML – MN – MO e MS) have very similar problems, such as:

- Leakages in networks and branch lines:
  The branch line is one of the most delicate parts subject to leakages. According to the

Metropolitan Division (M), 93.5% of volume is lost because of leakages in that section. Even with an active leakage control (survey of non-visible leakages), it is not possible to eliminate all leakages, as some non-visible inherent leakages remain, i.e., those that are not detected not even by the most modern methods and acoustic detection equipment.

- Advanced age of networks:
  Most of networks have ages that exceed their lifespan and require replacement, or are made of a material the replacement of which is recommended.
- Water shortage in critical points:
  After SPMR disorderly, continuous growth, the current demand for water supply is not uniform and requires the rationalization of its distribution and consequent loss minimization through sectorization studies in several locations.
- Poor quality of material used in branch lines (black PEAD), made of zinced iron.
- High pressure and pressure variation:
  Need of a higher control of facilities to minimize losses.
- Tapping:
  Need of sectorization studies to reduce tapping.
- Irregular areas
  Existence of several irregular housing agglomerates (squatted areas).

R systems are located in the hinterland and cost of the State of São Paulo, where most of municipalities are considered small. There are municipalities with large demographic concentrations, where problems are similar to those in SPMR, although regionalized.

The following tables show the evolution of some indicators, which reflect the application of some actions focused on loss control in each UN. Table 9-2 shows data related to volumes of water distributed and lost, and Table 9-3 shows the evolution of loss rate (IPDt) in 2004-2009 (July).

Table 9-2 – Indices of water supply in Business Units (2009)

UN	Component Systems	Priority Systems	Assisted Population	Network Length	Average Connections	Inactive connections	Supplied Volume	Micromeasured Volume	Social Volume	Billed Volume	Loss Volume (M)	Transferred Volume	IPF	IPDt	Booster	VRP	Avg. Leakages per year
					N		Vp	Vm	U	Vf	Vp-Vm-U	T	(Vp-Vf-U)/(Vp+T)	(Vp-Vm-U)/N/360			
	unit	unit	Inhabit.	km	unit	unit	m³/year	m³/year	m³/year	m³/year	m³/year	m³/year	%	l/con/day	unit	unit	leak./year
MC	29	21	3,000,000	5,860	704,380	64,942	413,023,789	287,076,890	22,719,625	309,153,043	103,227,274	53,430,669	17.4%	402	18	208	30,936
ML	20	15	3,300,000	6,050	788,740	73,352	281,192,241	155,183,009	18,839,651	177,638,646	107,169,581	32,488,957	27.0%	372	58	160	57,844
MN	30	20	2,900,000	5,153	750,894	94,334	304,918,945	164,644,381	29,082,149	183,984,120	111,192,415	2,625,405	29.9%	406	145	230	55,172
MO	44	32	3,100,000	6280	691,168	71,244	320,430,204	176,630,623	34,248,206	195,325,248	109,551,375	403,154	28.3%	434	99	205	39,233
MS	49	27	3,400,000	6,940	818,278	61,716	396,850,495	190,162,106	62,022,778	212,606,585	144,665,611	53,540,683	27.1%	484	81	198	42,232
M	**172**	**115**	**15,700,000**	**30,283**	**3,753,460**	**365,588**	**1,716,415,674**	**973,697,009**	**166,912,409**	**1,078,707,642**	**575,806,256**	**142,488,868**	**25.3%**	**420**	**401**	**1001**	**225,417**
RA	48	5	741,000	3,216	251,336	25,751	58,189,860	36,257,693	643	43,286,168	21,931,524	0	25.6%	239	41	58	18,326
RB	62	1	835,000	3,549	294,579	26,976	68,211,299	49,340,749	148,148	55,467,973	18,722,402	0	18.5%	174	8	50	28,260
RG	29	1	724,000	2,494	249,549	20,486	58,656,274	42,855,156	111,256	48,551,041	15,689,862	0	17.0%	172		163	15,579
RJ	12	9	588,000	1,929	187,701	12,513	62,188,629	33,837,771	1,962,399	38,342,304	26,388,459	0	35.2%	385	65	38	17,601
RM	35	15	718,000	2,980	247,051	22,763	75,387,640	40,721,397	0	47,093,236	34,666,243	0	37.5%	384	84	66	22,105
RN	4	1	244,000	1,238	102,688	10,483	32,875,090	18,770,313	0	24,544,025	14,104,777	0	25.3%	376	80	38	13,151
RR	23	0	248,000	1,340	93,603	14,696	18,867,759	12,905,400	0	16,042,902	5,962,359	0	15.0%	175			5,836
RS	10	6	1,490,000	5,521	442,153	65,716	206,183,010	109,668,974	14,445,625	137,274,826	82,068,411	0	26.4%	509			27,598
RT	83	0	594,000	2,565	216,370	14,551	46,104,561	36,745,719	74,241	41,195,443	9,284,601	0	10.5%	118		52	12,927
RV	24	5	1.323.000	4.488	402,579	33.932	130.198.081	82.247.499	247.181	91.199.704	47.703.401	0	29,8%	325		188	34.699
R	330	43	7,505,000	29,320	2,487,609	247,867	756,862,203	463,350,671	16,989,493	542,997,622	276,522,039	0	26.0%	305			196,082
Total	502	158	23,205,000	59,603	6,241,069	613,455	2,473,277,877	1,437,047,680	183,901,902	1,621,705,264	852,328,295	142,488,868	25,5%	374			421,499

(2) Daily water loss rate per connection (IPDt)

The Table below shows IPDt variation in each Business Unit in 2004-2009

Table 9-3 - IPDt Variation in each Business Unit

UN	2004	2005	2006	2007	2008	2009
MC	618	558	548	498	430	402
ML	580	540	555	464	393	372
MN	527	498	508	461	441	406
MO	576	489	453	454	459	434
MS	699	634	634	582	529	484
M	601	546	543	493	451	420
RA	280	270	275	258	251	239
RB	236	234	221	210	182	174
RG	202	204	199	186	176	172
RJ	444	450	462	424	398	385
RM	411	413	406	416	394	384
RN	481	483	449	393	375	376
RR	218	219	221	199	174	175
RS	621	629	566	566	517	509
RT	127	135	129	124	119	118
RV	420	389	390	373	354	351
R	369	366	354	338	315	309

9-2 Characteristics and Problems in each BU

9-2-1 MC – Central Business Unit

(1) Characteristics

MC has been taking water loss control actions in a very intensive manner since 2004, and its former IPDt rate of 618 (2004) reached 402 l/(connection. x day) in July 2009. It was determined that most of that rate derives from leakages. Network replacements started in 2007 with 21.3 km, 19.6 km in 2008 and 6.0 km until May 2009. It has obtained significant results in water loss reduction, especially because of its VRP implantation policy, follow-up of minimum nigh outflows (Qmn), and intensification of non-visible leakage survey activities. The set of such actions has allowed a greater control of pressure and outflows offered to supply sectors (systems) under its responsibility. The whole action is taken in the form determined by PRP - Regional Loss Plan in all 29 systems, 11 of which are considered critical.

MC controls the pressure of all 29 operated systems. For example, in Mooca sector, there is a working pressure area exceeding 70 mca, what indicates that pressure control in that location is critical. After installation of VRPs, MC has confirmed their efficiency in IPDt reduction, through the collection and analysis of data before and after VRP installation, thus allowing the database to be created to support

the decision making process.

Most of the region under MC responsibility comprises the central area of the city of São Paulo, and as such is provided with very old hydraulic facilities (networks and branch lines) (e.g., zinced iron branch lines, cement networks, asbestos cement networks, among others). With the objective of optimize as much as possible the scarce funds available, the preventive replacement of branch lines was adopted more aggressively than in other Metropolitan BU's. Thus, since 2006 corrective replacement has changed to preventive replacement. Only 35% of replacements are corrective, and the majority (65%) is preventive.

(2) Main Problems

Refer to common problems in the Metropolitan Division (9-1).

9-2-2 ML – East Business Unit

(1) Characteristics

ML has currently 24 reservoirs and 50 Boosters under its control

ML has created a group for survey of meter undermeasurement, with the objective of adapting itself to the current reality of undermeasured calculation, which is considered obsolete. To date, MF has surveyed more than 30,000 units as a measure against illegal connection, and its current irregularity rate is around 22%. Leakage survey concentrates in the central area of the unit (São Miguel Paulista).

Its current loss rate is 372 l/(connection. x day) achieved in June 2009.

(2) Main Problems

Refer to common problems in the Metropolitan Division (9-1).

9-2-3 MN – North Business Unit

(1) Characteristics

Out of all systems comprising MN, 20 are considered of high priority. Among them, the district or Casa Verde stands out, as 110 of its existing 1,000 branch lines have leakages. Another system that concentrates the main MN problems is Vila Medeiros, for which actions have been determined through the analysis of data on networks and branch lines. The current loss rate in this UN is 406 liters/(connection x day).

(2) Main Problems

Refer to common problems in the Metropolitan Division (9-1).

9-2-4 MO – West Business Unit

(1) Characteristics

Like other UNs, MO has been performing loss control activities for many years, through the implantation of pilot systems, and what have allowed it to achieve an improvement of loss rates from 576 l/(connection x day) in 2004 to 434 l/(connection x day) in July 2009.

In MO, loss issues are analyzed by work groups that dedicate themselves to study thoroughly all relevant issues and propose solutions, through PDCA cycle (P = planning, D = execution, C = control and A = corrective action).

The group is constituted to assist a particular system and tries to plan the implementation of actions to control and reduce losses, such as: implantation of VRP, micrometer, diagnosis of water meter center, networks and branch lines. Depending on results, it proposes the necessary replacements. Results are evaluated on a monthly basis, or extraordinarily to discuss more specific matters.

There are currently 69 VRPs, 5,961 km of networks, and 658,875 branch lines

(2) Main Problems

Refer to common problems in the Metropolitan Division (9-1).

9-2-5 MS – South Business Unit

(1) Characteristics

Currently, 21 actions in general are in execution in MS. The current loss rate is 484 l/(connection x day)that, through branch line replacement, pressure control and leakage repair, is expected to decrease gradually. Every month a meeting on Loss Reduction is held, attended by all Maintenance Centers, with the objective of improving interaction in the organizational framework. MS develops non-visible leakage surveys through a hired company, the current result of which is 1.2 - 1.4 leakages per km. Cast iron pipes installed in MS are more than 40 years-old, what contributes substantially to the difficult system operation, including by causing low pressure. Another action that has a strong impact on loss control in region managed by MS, is the identification of irregular connections, most of which concentrate in reservoir areas. Currently, 35% of such connections are made in the form of bypass.

(2) Main Problems

Refer to common problems in the Metropolitan Division (9-1).

9-2-6 RA –Alto Paranapanema Business Unit

(1) Characteristics

RA Business Unit is located more to the south of the State of São Paulo in lower Paranapanema River basin, which is responsible for water supply and sewage treatment for a population of approximately 910,457 inhabitants. It comprises 48 municipalities (systems), of which the municipality of Itapetininga is the UN seat with 156,760 inhabitants. In addition, it has three other municipalities (Avaré, Itapeva e Itararé) with more than 50,000 inhabitants. There are also 3,216 distribution networks with 251,336 active connections, 58 VRPs and 41 Boosters. Currently, its loss rate (IPDt) averages 239 liters/connections x day.

(2) Main Problems

Some of RA main problems are listed below:

- Unavailability of labor for survey and repair of non-visible leakages (hiring constraints and unavailability of internal human resources);
- Old networks and deficient technical records;
- Several limitations for adequate monitoring of high pressure and solution of resulting problems (lack of records / sectorization / lack of funds for investment);
- Difficulty in transportation and labor for pitometry and macromeasurement (micrometer calibration) teams;
- Difficulty in installation of macrometers due to deficient labor / purchase of equipment (funds);
- Reduced pitometry team, which is practically limited to calibrations and lacks specific skills (e.g., instrumentation);
- Existence of distribution networks and branch lines more than 50 years-old;
- High number of Boosters and difficulty of labor to operate them, in addition to the need of installed frequency inverters for better pressure control.
- Inconsistence of commercial ant technical information sectors;
- Lack of structure to control irregular connections (labor, equipment, vehicles, etc);
- Difficulty to implement a schedule or branch line replacements (funds).
- Micromeasurement
  - Insufficient labor for planning and execution of medium to long-term regularization services in hydrometry area;
  - Old water meters requiring the improved implementation of preventive replacement (shortage of funds);
  - Need to improve the information census.

9-2-7 RB – Baixo Paranapanema Business Unit

(1) Characteristics

RB is located in far western portion of the State of São Paulo, on the border with the States of Mato Grosso do Sul and Paraná, in Peixe and Parapanema river basins, and comprises a population of 988,00 inhabitants. The largest municipality is Presidente Prudente, UM seat, with 206,164 inhabitants. Except for three municipalities (Tupã, Quintana and Assis, the populations of which exceed 50,000 inhabitants), each of all other municipalities has less than 30,000 inhabitants. It has a 3,549-km long sewerage network with 294,579 active connections, 50 VRPs and 8 Booster's. Because of the age of cast iron and fiber cement pipes and poor quality of branch line material, loss rate is considered high in most of municipalities. For example, in Presidente Prudente, it is 290 l/(connections x day) versus an average of 174 l/(connections x day) in RB.

(2) Main Problems

Main RB problems include:

- Deficient update of technical record of pipelines, water distribution networks and valves;
- High pressures in some pipelines and networks, in particular in the priority municipality.
- Old and poor-quality material applied to networks and branch lines.
- Disorderly growth of municipalities.
- Existence of asbestos cement distribution networks and eroded networks more than 50 years-old;
- Lead-jointed pipelines still in operation.
- Irregular connections:
  - deficient structure (labor, logistics) to fight irregularities;
  - unavailable teams trained to seek for frauds;
  - need of review of commercial records.

9-2-8 RG – Pardo and Grande Business Unit

(1) Characteristics

RG Business Unit is located on the northeastern region of the State of São Paulo, in Pardo and Grande river basins. It is responsible for water supply in 29 municipalities, of which its seat, Franca (330,000 inhabitants) is the most important. There are surface water sources (80%) and groundwater sources. Collected water is treated in 2- Treatment Plants (ETA) and 14 chlorination and fluoridation sites. It has a 2,494-km long network, 249,549 active connections, 75 pumping stations and 175 distribution reservoirs. In addition, there are 31 production systems with supervised distribution, 196 measurement and control districts, and 163 installed VRPs. It serves a total population of 796,000 inhabitants. Its current loss rate is 172 l/(connection. x day).

(2) Main Problems

Main problems include:

- Leakages in networks and branch lines (requires the replacement of branch lines and networks, survey of non-visible leakages, repair of visible leakages in networks, and replacement of water meters;
- Advanced age of networks:
- Quality of branch line material (black PEAD and zinced iron).
- Control of irregular connections

9-2-9 RJ –Capivari / Jundiaí Business Unit

(1) Characteristics

RJ Business Unit is located in the southeastern region of the State of São Paulo, in Piracicaba, Capivari and Jundiaí river basins. It is responsible for water supply and sewage treatment in 12 municipalities, covering a population of approximately 790,000 inhabitants. Because RJ is a relatively new unit, new municipalities are likely to adhere to the Sabesp system. It has 187,701 active connections and a 1,929-km long distribution network. In 2008, there were 3,964 replacements of branch lines, 22 km of network rearrangement, sectorization in 2 districts, 20,000 preventive replacements of water meters, 30,000 deactivations and suppressions, 1,614 fraud-search inspections, 1040 of which were confirmed, and water meters redesign. Its current loss rate is 385 l/(connections x day).

(2) Main Problems

Main problems in component systems include:

- Deficient technical record of pipelines, water distribution networks and valves;
- High pressures in some areas;
- Existence of eroded asbestos cement pipelines and networks more than 50 years-old;
- Lack of structure to control irregular connections (labor, equipment, vehicles, etc);
- Low level of sectorization with macromeasurement;
- There are no measurement and control districts;
- Poor-quality branch-line material requiring replacement.
- High rates of leakage repairs in networks and branch lines.

9-2-10 RM –Médio Tietê Business Unit

(1) Characteristics

RM Business Unit is located in the central part of the State of São Paulo and includes 35 municipalities. The operational water supply structure comprises basically a 3,307-km long water

distribution network with 245,440 active connections, and serves a population of approximately 922,200 inhabitants. Only four municipalities (Botucatu, Ibiúna, São Roque and Tatuí) have each a population in excess of 50,000 inhabitants. Currently there are 66 VRPs and 94 Boosters to control its water distribution, with a loss rate of 378 l/(connections x day).

(2) Main Problems

Main problems founds in RM are listed below:

- Incomplete or unavailable technical records on pipelines;
- Lack of an efficient pressure control in distribution networks;
- Occurrence of asbestos cement distribution network and eroded pipelines;
- Branch lines made of inadequate material in water connections (black PEAD and rotten valve);
- High number of Boosters and VRPs;
- Deficient macromeasurement system;
- Active leakage control (survey and repair) discontinued for lack of financial and human resources;
- Unskilled outsourced labor;
- Unavailable sectorization and Measurement and Control Districts;
- Need of operational improvements to minimize leakages and overflows in reservoirs, discharges of filter wash water, network discharges, water loss in productive process, and incorrect operations;
- Outdated commercial records;
- High rate of frauds;
- Micromeasurement:
  - Water meters with expired installation period and/or excessive reading;
  - Non-standard racks making frauds easier;
  - Discontinuity of resources (financial and human resources) for preventive replacements of water meters.

9-2-11 RN – Litoral Norte Business Unit

(1) Characteristics

RN is locates in the north coast of the State of São Paulo where it is responsible for 4 municipalities comprising a total population of 272,168 inhabitants. All such municipalities have a very high seasonal oscillation that considerably affects the water distribution process during weekends and extended holidays, school holidays and Christmas season. It has a 1,215-km long distribution network including 99,444 active connections, 38 VRPs and 80 Boosters, and a loss rate of 375 l/(connections x day).

(2) Main Problems

Main RN problems include:

- Seasonality: floating population in summer holidays is greater than the fixed population;
- Sandy soil and high water table make the detection of non-visible leakages difficult;
- Deficient technical record of pipelines, water distribution networks and valves;
- High pressures in pipelines, in particular in the priority municipality (São Sebastião);
- Most of pipelines are parallel with or on roadbeds, what makes leakage detection by acoustic method difficult;
- Lack of physical space fir implantation of pipeline duplication on the road between Caraguatatuba and São Sebastião, especially because of the sloping stretch in São Sebastião;
- Long coastal strip served by UN (approximately 210 km from Itamambuca/Ubatuba to Barra do Una/São Sebastião), in addition to Ilhabela area;
- Disorderly growth of municipalities;
- Occurrence of asbestos cement distribution network and eroded pipelines;
- Lead-jointed pipelines still in operation.
- High number of Boosters;
- Irregular connections:
  - deficient structure (labor, procedures, logistics) to fight irregularities;
  - priority areas are populated by low-income inhabitants, has no paved streets (earth/sand), what encourages the population to make irregular connections;
- Micromeasurement
  - reading regrouping has started, but its completion is indeterminate due to unavailable own labor;
  - difficult preventive replacements of water meters in seasonal real estates;
  - insufficient labor for medium and long-term planning in hydrometry area.

9-2-12 RR – Vale do Ribeira Business Unit

(1) Characteristics

RR Business Unit is located in the southern region of the State of São Paulo, and is responsible for water supply and sewage treatment in 23 municipalities with a total population of approximately 378,000 inhabitants. Each of such municipalities, except Registro, where its seat is located, has a population of less than 35,000, being regarded as small municipalities in the State of São Paulo, as their demographic density is 21 inhabitants/km^2.

It has a 1,266-km long water distribution network and 90,607 active connections. Its loss control started in 2001; currently its IPDt is 172 l/(connections x day), as determined in April 2009.

(2) Main Problems

Main RR problems include:

- Leakages in networks and branch lines;
- Advanced age of networks:
- Water shortage in critical points;
- Quality of branch line material (black PEAD and zinced iron);
- High pressure and pressure variation;
- Irregular areas.

9-2-13 RS – Baixada Santista Business Unit

(1) Characteristics

RS Business Unit covers the whole Baixada Santista (Santos Lowlands) and is responsible for water supply and sewage treatment in 9 large municipalities comprising a total fixed population of 1,930,220 inhabitants. This population increases considerably during summer vacations to as many as 2.5 times its fixed population. It has a 5,485-km long distribution network and 429,516 active connections. Serving an increase of low-income population settlements spread out along its coast is necessary. Some 50% of its water distribution facilities are considered old, such as, for example, some 280,000 water meters and most of its water distribution network.. Actions for current loss control are concentrated in Praia Grande and Guarujá regions. Its current loss rate is 509 l/(connections x day).

(2) Main Problems

RS problems are similar to those in SPMR (MA), aggravated by seasonal water supply problems due to its floating population. Among the most necessary actions to minimize water losses, sectorization stands out because of the markedly growing occurrence of several settlements with irregular supply (Navy area and squatted land).

9-2-14 RT – Baixo Tietê and Grande Business Unit

(1) Characteristics

RT Business Unit is located in the northwestern region of the State of São Paulo, on Tietê and Grande River basins, and is responsible for water supply and sewage treatment in 83 municipalities comprising a population of approximately 673,226 inhabitants. Most of component municipalities have a low population, except two of them with populations above 50,000 inhabitants each (Lins, where RT seat is located, and the municipality of Fernandópolis). It has a 2.569-km long water distribution network and 210,449 active connections. Its IPDt is considered low as compared to Sabesp average, at 117 l/(connections x day). It has been confirmed that 88% of leakages in branch lines derive probably from the poor quality of PEAD pipe (black) with a long time of use.

(2) Main Problems

RT main problems consist of:

- Punctual demand for network rearrangement (age and inadequate material);
- Need of organization of non-visible leakage survey process (resources);
- Need of organization of leakage repair process (resources, training and adequacy of material).
- Need of replacement of high and low-capacity water meters;
- Adequacy of macromeasurement system;
- Need of record update.

9-2-15 RV – Vale do Paraíba Business Unit

(1) Characteristics

RV Business Unit is located near São Paulo Metropolitan Region, between São Paulo and Rio de Janeiro, a place of great economic development in the country, which houses important industries. Its system comprises 24 municipalities, a population of approximately 1,300,000 inhabitants, 4,391-km long distribution network and 388,939 active connections. Among those municipalities, São José dos Campos stands out with 609,229 inhabitants, where RV seat is located.

Most of its distribution network is made of PVC, cast iron and asbestos cement, is approximately 40 years-old and consequently requires replacement. In all RV municipalities, loss rate is relatively high averaging 350 l/(connections x day).

(2) Main Problems

Main problems consist of:

- Punctual demand for network rearrangement (age and inadequate material);
- Punctual demand for branch line replacement (age and inadequate material);
- Need of organization of non-visible leakage survey process (resources);
- Need of organization of leakage repair process (resources, training and adequacy of material).
- Need of macrometer adequacy;
- Inadequate water meter center (age and need of new specifications in case of great consumers);

9-3 General Considerations on JICA Stage Actions

All 502 component systems have been grouped into two different groups: a group including 158 priority systems, and another group including all systems.

For Priority Group, 4 project components will be applied, as follows:

- Replacement of networks (including branch lines);

- Sectorization;
- VRP installation;
- Boosters Installation.

Project design for PROGRAM components (basic actions, corrective actions, preventive actions, water distribution control actions, and social actions comprising the loss reduction actions) for all systems (Whole Group) was described in item 8-4 "Methodology for PROGRAM Structuring".

9-4 Loss Reduction Program for Business Units (2011 – 2013)

Based on the current status of losses and problems, each Business Unit designed its own project during JICA Stage, according to "Preliminary Project and Order of Priority Criteria".

The following Tables show those quantity schedules.

9-4-1 MA – Water Producer Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	0	0	0	0
A1.2	Replacement of networks/branch lines	Physical Network (km)	0	0	0	0
		Physical Branch L (unit)	0	0	0	0
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	0	0	0	0
A2	Leakage Survey	Physical (km)	33	33	33	99
A3.1	Leakage Repair in Network	Physical (unit)	0	0	0	0
A3.2	Repair of non-visible leakage (network)	Physical (unit)	0	0	0	0
A4.1	Sectorization (pressure zones)	Physical-project (un	0	0	0	0
		Physical-Work (unit)	0	0	0	0
A4.2	VRP	Physical (unit)	0	0	0	0
A4.3	DMC	Physical (unit)	0	0	0	0
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)				
A5	Equipment	Physical (unit)	0	0	0	0
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	0	0	0	0
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	0	0	0	0
B2.1	Inactive inspections	Physical (unit)	0	0	0	0
B2.2	Irregularity Control	Physical (unit)	0	0	0	0
	UMA Installation	Physical (unit)	0	0	0	0
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	0	0	0	0
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	6	3	6	15
C2	Macrometer Calibration	Physical (unit)	234	234	234	702
C3	Capacity Building	Physical (unit)	0	0	0	0
C4	Socioeducative Actions	Physical (unit)	0	0	0	0

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

This Business Unit deals exclusively with water production for all SPMR Business Units, MC, ML, MN, MO, MS and other municipalities not operated by Sabesp (Mogi das Cruzes, Diadema, Guarulhos, Santo André, Mauá and São Caetano).

During JICA Stage (2011-2013), it participates in the implementation of two specific actions: survey of non-visible leakages in networks (A2) and micrometer calibration and installation (C2).

9-4-2 MC – Central Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	37,875	37,496	37,122	112,493
A1.2	Replacement of networks/branch lines	Physical Network (km)	50	43	52	145
		Physical Branch Li (unit)	4,906	4,621	5,995	15,522
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	1,022	1,022	1,022	3,066
A2	Leakage Survey	Physical (km)	4,231	4,231	4,231	12,693
A3.1	Leakage Repair in Network	Physical (unit)	4,486	4,442	4,397	13,325
A3.2	Repair of non-visible leakage (network)	Physical (unit)	146	146	146	438
A4.1	Sectorization (pressure zones)	Physical-project (uni	0	0	0	0
		Physical-work (unit)	2	1	1	4
A4.2	VRP	Physical (unit)	2	4	3	9
A4.3	DMC	Physical (unit)	19	16	21	56
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	76	74	50	200
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	5,933	5,899	5,899	17,731
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	54,194	54,194	54,194	162,582
B2.1	Inactive inspections	Physical (unit)	0	0	0	0
B2.2	Irregularity Control	Physical (unit)	2,356	2,356	2,356	7,068
	UMA Installation	Physical (unit)	177	177	177	531
B2.3	Slum regularization	Physical (unit)	926	714	1,050	2,690
B3	Record Update	Physical (unit)	0	0	0	0
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	6	9	5	20
C2	Macrometer Calibration	Physical (unit)	3	3	3	9
C3	Capacity Building	Physical (unit)	13	13	13	39
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

Currently, MC loss rate amounts to 402 l(connections x day) – July 2009, while funds to be applied to real loss control are equivalent to some 65% of investment allocated to MC, mostly corresponding to inherent leakages mainly due to the age of facilities.

MC comprises 29 systems, 21 of which are classified as priority. Like in all other M UNs, SIGNOS system is used to manage 120,000 connections that are part of the 750-m long network in MC priority systems.

MC history indicates that leakage occur in 5% of networks, 35% of branch lines and 60% of racks. According to MC planning, 605 km will be replaced over 11 years, being 145 km during JICA Stage.

Twelve (12) sectorizations will be made under the PROGRAM, 4 of which during JICA Stage. In addition, 29 VRPs will be installed, 30% of which in 2011-2013 period, and efforts will focus on the installation of 180 DMCs, 56 of which during JICA Stage.

9-4-3 ML – East Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	52,114	51,593	51,077	154,784
A1.2	Replacement of networks/branch lines	Physical Network (km)	49	36	76	161
		Physical Branch Li (unit)	6,926	5,318	9,788	22,032
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	4,468	4,468	4,468	13,404
A2	Leakage Survey	Physical (km)	4,471	4,471	4,471	13,413
A3.1	Leakage Repair in Network	Physical (unit)	3,683	3,646	3,609	10,938
A3.2	Repair of non-visible leakage (network)	Physical (unit)	316	316	316	948
A4.1	Sectorization (Pressure Zones)	Physical-project (un	0	0	0	0
		Physical-Work (unit)	1	1	1	3
A4.2	VRP	Physical (unit)	11	7	6	24
A4.3	DMC	Physical (unit)	25	26	24	75
A4.4	Booster	Physical (unit)	3	2	5	10
A4.5	Slum closing	Physical (unit)	0,5	0,5	0	1,0
A5	Equipment	Physical (unit)	34	34	19	87
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	1.337	1.368	1.368	4.073
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	104,029	104,029	104,029	312,087
B2.1	Inactive inspections	Physical (unit)	65,964	65,964	65,964	197,892
B2.2	Irregularity Control	Physical (unit)	26,608	26,608	26,608	79,824
	UMA Installation	Physical (unit)	5,322	5,322	5,322	15,966
B2.3	Slum regularization	Physical (unit)	1,190	994	999	3,183
B3	Record Update	Physical (unit)	152,044	152,044	152,044	456,132
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	2	2	2	6
C2	Macrometer Calibration	Physical (unit)	66	68	70	204
C3	Capacity Building	Physical (unit)	999	200	932	2.131
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

Currently ML comprises 20 systems and its loss rate decreased from 643 l/(connections x day) in January 2004 to 368 l/(connections x day) in July 2009, and targets 220 l/(connections x day) in 2018. To achieve that target, it plans to take the following actions to minimize water loss: preventive and corrective replacement of water meters, reactivation of 7,500 connections, detection of 10,000 irregular connections, implementation of 17,000 new connections and suppression of 36.000 connections, scanning of irregularities as block level, and diagnosis of irregular areas. Sectorization action (pressure zones) to be implanted in ML is an important factor, as it consumes approximately 18% of its resources.

It currently manages a 6,068-km long network and 791,994 branch lines in all 20 systems, 15 of which are considered as priority.

Main actions:

- Scheduled replacement of 538 km over 11 years, 161 km of which during JICA Stage;

- Both the project and work implantation provide for 13 sectorizations for the whole PROGRAM, 3 of which during JICA Stage;
- Estimated installation of 83 VRPs, 24 of which during JICA Stage;
- Scheduled installation of 53 Boosters, 10 of which during JICA Stage;
- Plan for installation of 243 DMCs over a period of 11 years.

9-4-4 MN – North Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	49,999	49,499	49,004	148,502
A1.2	Replacement of networks/branch lines	Physical Netwo (km)	48	68	60	176
		Physical Bran Lines (unit)	5,853	9,626	8,109	23,588
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	4,003	4,002	4,002	12,007
A2	Leakage Survey	Physical (km)	4,009	4,009	4,009	12,027
A3.1	Leakage Repair in Network	Physical (unit)	5,091	5,040	4,990	15,121
A3.2	Repair of non-visible leakages (network)	Physical (unit)	396	396	396	1,188
A4.1	Sectorization – Pressure Zones	Physical-project (un	0	0	0	0
		Physical-work (uni	0	0	0	0
A4.2	VRP	Physical (unit)	11	2	2	15
A4.3	DMC	Physical (unit)	28	21	19	68
A4.4	Booster	Physical (unit)	12	10	6	28
A4.5	Slum closing	Physical (unit)	0.4	0.4	0	0.8
A5	Equipment	Physical (unit)	50	30	30	110
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	909	903	903	2.715
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	101,152	101,152	101,152	303,456
B2.1	Inactive inspections	Physical (unit)	62,165	62,165	62,165	186,495
B2.2	Irregularity Control	Physical (unit)	25,835	25,835	25,835	77,505
	UMA Installation	Physical (unit)	2,842	2,842	2,842	8,526
B2.3	Slum regularization	Physical (unit)	3,913	3,913	3,913	11,739
B3	Record Update	Physical (unit)	66,971	66,971	66,971	200,913
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	0	0	0	0
C2	Macrometer Calibration	Physical (unit)	0	0	0	0
C3	Capacity Building	Physical (unit)	40	40	40	120
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

MN indicators show a reduction, in spite of frequent labor hiring problems: lack of branch line maintenance, repair and replacement contract. Nevertheless, MN performance achieved satisfactory results in relation to its targets. For example, in 2008: 6,000-km non-visible leakage survey was scheduled, but 11,138 were completed (6,000 km/11,338 km), network rehabilitation (10,000 m/14,467 m), branch line replacement (14,000 units/23,504 units; installation of VRPs (8/20); inspection of irregular connections (8,404/11,098); water meter replacements (90,000/161,796). Therefore, MN intends to implement continuously the replacement of branch lines and water meters. Funds allocated to control Real Losses are equivalent to approximately 73% of estimated resources.

Significant Items:

- There is a plan to replace 524 km over a period of 11 years, 176 during JICA Stage;
- Both project and works provide for the sectorization of 2 municipalities, but none of them during JICA Stage;
- Installation of 28 VRPs, 15 of which during JICA Stage;
- 50 Boosters are scheduled to be installed, 28 of which during JICA Stage;
- Installation of 137 DMCs.

9-4-5 MO – West Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	33,429	33,095	32,764	99,288
A1.2	Replacement of networks/branch lines	Physical Network (km)	23	48	26	97
		Physical Branch Li (unit)	2,032	6,273	3,319	11,624
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	4,449	757	4,448	9,654
A2	Leakage Survey	Physical (km)	4,683	4,682	4,682	14,047
A3.1	Leakage Repair in Network	Physical (unit)	1.759	1.742	1.724	5.225
A3.2	Repair of non-visible leakages (network)	Physical (unit)	234	40	234	508
A4.1	Sectorization (pressure zones)	Physical-project (uni	6	6	0	12
		Physical-work (unit)	1	3	11	15
A4.2	VRP	Physical (unit)	15	12	11	38
A4.3	DMC	Physical (unit)	33	29	26	88
A4.4	Booster	Physical (unit)	5	1	0	6
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	115	78	57	250
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	2,040	2,063	2,063	6,166
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	89,830	89,830	89,830	269,490
B2.1	Inactive inspections	Physical (unit)	71,438	71,438	71,438	214,314
B2.2	Irregularity Control	Physical (unit)	15,978	15,978	15,978	47,934
	UMA Installation	Physical (unit)	3,196	3,196	3,196	9,588
B2.3	Slum regularization	Physical (unit)	5,901	5,484	5,484	16,869
B3	Record Update	Physical (unit)	131,776	131,776	131,776	395,328
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	6	4	1	11
C2	Macrometer Calibration	Physical (unit)	54	54	54	162
C3	Capacity Building	Physical (unit)	18	18	18	54
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

Over the last recent years, MI loss rate decreased from 560 liters/(connections x day) (June 2004) to 430 liters/(connections x day) in July 2009. In MO there are 44 systems, 32 of which are considered as priority. MO houses one of pilot sectors of Eficaz Project. Important MO aspects:

- Planned replacement of 348 km over a period of 11 years, 97 km of which during JICA Stage;

- There are currently 658,875 branch lines, 9,654 of which are scheduled to be replaced during JICA Stage;
- Both project and works provide for 93 sectorizations, 27 of which during JICA Stage;
- Scheduled installation of 9 Boosters, 6 of which during JICA Stage;
- 259 DMCs will be installed over a period of 11 years.

9-4-6 MS – South Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	61,964	61,345	60,731	184,040
A1.2	Replacement of networks/branch lines	Physical Network (km)	47	43	38	128
		Physical Branch Li (unit)	5,408	4,564	3,904	13,876
A1.3	Branch Line Replacement – Leaka Survey	Physical (unit)	4,630	4,630	4,630	13,890
A2	Leakage Survey	Physical (km)	5,033	5,033	5,033	15,099
A3.1	Leakage Repair in Network	Physical (unit)	5,388	5,334	5,281	16,003
A3.2	Repair of Non-Visible Leakages (network)	Physical (unit)	403	403	403	1,209
A4.1	Sectorization (pressure zones)	Physical-project (uni	1	1	0	2
		Physical-work (unit)	1	1	1	3
A4.2	VRP	Physical (unit)	25	13	12	50
A4.3	DMC	Physical (unit)	54	34	21	109
A4.4	Booster	Physical (unit)	6	3	1	10
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	60	81	114	255
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	1,048	1,055	1,055	3,158
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	106,121	106,121	106,121	318,363
B2.1	Inactive inspections	Physical (unit)	85,870	85,870	85,870	257,610
B2.2	Irregularity Control	Physical (unit)	9,296	9,296	9,296	27,888
	UMA Installation	Physical (unit)	1,859	1,859	1,859	5,577
B2.3	Slum regularization	Physical (unit)	5,398	5,534	5,416	16,348
B3	Record Update	Physical (unit)	154,929	154,929	154,929	464,787
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	4	2	3	9
C2	Macrometer Calibration	Physical (unit)	3	3	3	9
C3	Capacity Building	Physical (unit)	87	75	50	212
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

This unit represents the greatest M investment and accounts for 15% of all JICA Stage resources. Its current loss indicator is 484 liters/(connections x day) (June 2009), and it is intended to apply 77% of its resources to Real Loss control actions, of which sectorization is a major component. Another important aspect is the occurrence of low-income settlements mostly on the margins of water sources.

MS manages 50 systems, 27 of which as considered as priority. It comprises currently 6.710 km of networks and 774,648 branch lines. The following is planned for this UN:

- Out of total 6,710 km of networks, 4,693 km of which are included in priority sectors, 383 km are scheduled to be replaced over a period of 11 years, 128 of which during JICA Stage;

- Five sectorizations are planned (project and works) during the PROGRAM, all of them to be implanted during JICA Stage.
- 105 VRPs will be installed until 2015, 50 of which during JICA Stage;
- Scheduled installation of 24 Boosters, 10 of which during JICA Stage;
- Plan for installation of 276 DMCs throughout the whole PROGRAM.

9-4-7 RA –Alto Paranapanema Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	14,762	14,615	14,468	43,845
A1.2	Replacement of networks/branch lines	Physical Network (km)	4	4	6	14
		Physical Branch Li (unit)	400	400	605	1,405
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	1,832	1,832	1,832	5,496
A2	Leakage Survey	Physical (km)	2,261	2,261	2,261	6,783
A3.1	Leakage Repair in Network	Physical (unit)	3,515	3,480	3,445	10,440
A3.2	Repair of non-visible leakages (network)	Physical (unit)	436	436	436	1.308
A4.1	Sectorization (pressure zones)	Physical-project (uni	4	1	1	6
		Physical-work (unit)	1	3	1	5
A4.2	VRP	Physical (unit)	8	0	0	8
A4.3	DMC	Physical (unit)	13	16	23	52
A4.4	Booster	Physical (unit)	1	6	2	9
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	32	25	0	57
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	60	62	62	184
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	33,480	33,480	33,480	100,440
B2.1	Inactive inspections	Physical (unit)	25,125	25,125	25,125	75,375
B2.2	Irregularity Control	Physical (unit)	8,528	8,528	8,528	25,584
	UMA Installation	Physical (unit)	853	853	853	2,559
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	48,731	48,731	48,731	146,193
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	17	18	3	38
C2	Macrometer Calibration	Physical (unit)	187	187	187	561
C3	Capacity Building	Physical (unit)	4	4	4	12
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

Its current loss rate is 237 l/(connections x day) and RA has strongly pursued the minimization of that rate by taking several actions, especially with respect to the control of real losses, and applying to that problem 63% of its resources allocated to this PROGRAM.

RA Business Unit manages 48 municipalities (systems), 5 of which are considered as priority. It has 3,015 km of networks and 243,654 branch lines for which the following is planned:

- Replacement of 68 km over the period of 11 years, 14 km of which during JICA Stage;
- 19 sectorizations are planned (project and works) to be implanted during the PROGRAM, 11 of which during JICA Stage.

- Installation of 11 VRPs, 8 of which during JICA Stage;
- Sectorizations and installations of VRPs and Boosters should take place by 2014. Thereafter, relevant control and maintenance will be implemented;
- Plan for installation of 101 DMCs throughout the whole PROGRAM.

9-4-8 RB –Baixo Paranapanema Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	16,883	16,714	16,547	50,144
A1.2	Replacement of networks/branch lines	Physical Network (km)	4	4	4	12
		Physical Branch Li (unit)	358	358	358	1,074
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	1,886	1,886	1,886	5,658
A2	Leakage Survey	Physical (km)	2,591	2,591	2,591	7,773
A3.1	Leakage Repair in Network	Physical (unit)	1,669	1,653	1,636	4,958
A3.2	Repair of Non-Visible Leakages (network)	Physical (unit)	187	187	187	561
A4.1	Sectorization (pressure zones)	Physical-project (unit)	1	0	0	1
		Physical-work (unit)	2	2	2	6
A4.2	VRP	Physical (unit)	2	2	2	6
A4.3	DMC	Physical (unit)	0	2	3	5
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	14	10	5	29
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	135	138	138	411
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	39,090	39,090	39,090	117,270
B2.1	Inactive inspections	Physical (unit)	26,765	26,765	26,765	80,025
B2.2	Irregularity Control	Physical (unit)	4,270	4,270	4,270	12,810
	UMA Installation	Physical (unit)	213	213	213	639
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	28,466	28,466	28,466	85,398
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	38	10	1	49
C2	Macrometer Calibration	Physical (unit)	16	16	16	48
C3	Capacity Building	Physical (unit)	9	9	4	22
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RB current loss rate is 170 l/(connections x day). However, because of old cast iron and fiber-cement networks, there are a high number of leakages.

Main RB problems include:

- For all sectors, 50 km is estimated to be replaced over a period of 11 years, 12 km of which during JICA Stage.
- Thirteen (13) sectorizations are planned (project and works) during the PROGRAM, 7 of which will be implanted during JICA Stage.
- Installation of 15 VRPs, 6 of which during JICA Stage;
- There is planned Booster installation;
- Installation of sectorizations and VRPs should take place by 2015, and thereafter their control and maintenance should be implemented;
- Plan for installation of 30 DMCs over 11 years of PROGRAM.

9-4-9 RG – Pardo and Grande Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
Real Loss						
A1.1	Branch line replacement	Physical (unit)	9,672	9,576	9,480	28,728
A1.2	Replacement of networks/branch lines	Physical Network (km)	18	24	24	66
		Physical Branch Li (unit)	2,123	2,196	2,406	6,725
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	1,457	1,457	1,457	4,371
A2	Leakage Survey	Physical (km)	1,822	1,822	1,822	5,466
A3.1	Leakage Repair in Network	Physical (unit)	2,418	2,394	2,370	7,182
A3.2	Repair of Non-Visible Leakages (network)	Physical (unit)	364	364	364	1,092
A4.1	Sectorization (pressure zones)	Physical-project (uni	0	0	0	0
		Physical-work (unit)	0	0	0	0
A4.2	VRP	Physical (unit)	0	0	0	0
A4.3	DMC	Physical (unit)	0	0	0	0
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	13	10	13	36
Apparent Loss						
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	0	0	0	0
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	37,313	37,313	37,313	111,939
B2.1	Inactive inspections	Physical (unit)	0	0	0	0
B2.2	Irregularity Control	Physical (unit)	4,319	4,319	4,319	12,957
	UMA Installation	Physical (unit)	1,296	1,296	1,296	3,888
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	0	0	0	0
Management						
C1	Installation/Adequacy of Macrometers	Physical (unit)	0	0	0	0
C2	Macrometer Calibration	Physical (unit)	40	40	40	120
C3	Capacity Building	Physical (unit)	50	50	50	150
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RG comprises 29 municipalities and distributes water to 100% of them, including 243,000 connections, 2,750-km long network, and 80% of surface water sources and 20% of groundwater sources. Its IPDt is currently 175 l(connections x day) due to:

- Rearrangement of distribution network and water connections in main component municipalities;
- Permanent fight against micromeasurement fraud;
- Periodic water meter gauging using special vehicles and operational automation/control is all its ETAs.

Currently, 90% of water meters are less than 10 years-old, and the target is a water meter age of less than 8 years. RG uses vehicles especially adapted to make branch line connections and leakage surveys through hearing rods. It should be stressed that 95% of RG leakages derive from branch lines, while networks average 1 leakage per km. Its distribution network is older than 50 years and is generally made of cast iron or asbestos cement.

Other significant aspects:

- Out of total 2.750 km of networks, 199 km are scheduled to be replaced under the PROGRAM, 66 of which during JICA Stage; The only priority sector is the municipality of Igarapava, where there is a total of 10 km of network to be replaced, 9 of which during JICA Stage;
- No projects, sectorization works or VRP and Booster installations are scheduled.

9-4-10 RJ –Capivari / Jundiaí Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	14,472	14,328	14,184	42,984
A1.2	Replacement of networks/branch lines	Physical Network (km)	16	16	16	48
		Physical Branch Lines (unit)	1,529	1,529	1,529	4,587
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	1,431	1,431	1,431	4,293
A2	Leakage Survey	Physical (km)	1,445	1,445	1,445	4,335
A3.1	Leakage Repair in Network	Physical (unit)	1,608	1,592	1,576	4,776
A3.2	Repair of Non-Visible Leakages (network)	Physical (unit)	159	159	159	477
A4.1	Sectorization (pressure zones)	Physical-project (uni	0	1	0	1
		Physical-work (unit)	3	0	0	3
A4.2	VRP	Physical (unit)	7	3	1	11
A4.3	DMC	Physical (unit)	9	9	9	27
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	0	5	0	5
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	0	0	0	0
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	24,508	24,508	24,508	73,524
B2.1	Inactive inspections	Physical (unit)	10,102	10,102	10,102	30,306
B2.2	Irregularity Control	Physical (unit)	6,239	6,239	6,239	18,717
	UMA Installation	Physical (unit)	811	811	811	2,433
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	35,649	35,649	35,649	106,947
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	0	0	0	0
C2	Macrometer Calibration	Physical (unit)	0	0	0	0
C3	Capacity Building	Physical (unit)	0	0	0	0
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RJ comprises 12 municipalities, 9 of which are considered as priority. It has currently 191,080 connections and an IPDt of 388 l/(connections x day). 75% of total funds allocated by the PROGRAM are estimated to be used by RJ to control Real Losses, especially the renewal of infrastructure (network and branch line replacement and survey of non-visible leakages).

Some significant aspects:

- There are 1,928 km of networks, 1,594 of which belong to priority sectors; 159 km are scheduled to be replaced over 11 years, 48 km of which during JICA Stage;

- Nine (9) sectorizations are planned (project and works) during the PROGRAM, 4 of which will be implanted during JICA Stage.
- Installation of 36 VRPs, 11 of which during JICA Stage;
- No Booster installation is planned;
- During the PROGRAM, 97 DMCs are schedule to be installed over a period of 11 years.

9-4-11 RM –Médio Tietê Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	17,108	16,937	16,767	50,812
A1.2	Replacement of networks/branch lines	Physical Network (km)	17	17	17	51
		Physical Branch Lines (unit)	1,321	1,321	1,321	3,963
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	1,822	1,822	1,822	5,466
A2	Leakage Survey	Physical (km)	2,277	2,277	2,277	6,831
A3.1	Leakage Repair in Network	Physical (unit)	4,561	4,515	4,470	13,546
A3.2	Repair of non-visible leakages (network)	Physical (unit)	455	455	455	1,365
A4.1	Sectorization (pressure zones)	Physical-project (uni	2	2	2	6
		Physical-work (unit)	2	2	2	6
A4.2	VRP	Physical (unit)	2	2	2	6
A4.3	DMC	Physical (unit)	7	7	7	21
A4.4	Booster	Physical (unit)	2	2	2	6
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	6	12	18	36
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	120	123	123	366
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	33,703	33,703	33,703	101,109
B2.1	Inactive inspections	Physical (unit)	19,940	19,940	19,940	59,820
B2.2	Irregularity Control	Physical (unit)	4,909	4,909	4,909	14,727
	UMA Installation	Physical (unit)	982	982	982	2,946
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	49,088	49,088	49,088	147,264
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	6	6	6	36
C2	Macrometer Calibration	Physical (unit)	0	0	0	0
C3	Capacity Building	Physical (unit)	28	28	28	84
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RM comprises 35 municipalities, 15 of which are considered as priority. It has currently 245,400 connections, a 3,037-km long network, and an IPDt of 638 l/(connections x day). 73% of total funds allocated by the PROGRAM are estimated to be used on basic loss control actions, such as: replacement of networks and branch lines, survey of non-visible leakages, implantation of sectorization and installation of VRP (real losses).

RM most important aspects include:

- Scheduled replacement of 717 km over 11 years of PROGRAM, 51 km of which during JICA Stage;

- 44 sectorizations are planned (project and works) during the PROGRAM, 12 of which will be implanted during JICA Stage.
- Installation of 18 VRPs, 6 of which during JICA Stage;
- Plan for installation of 22 Boosters, 6 of which during JICA Stage;
- Installation of 71 DMCs throughout the PROGRAM.

9-4-12 RN – Litoral Norte Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Replacement of Branch Lines (+ preventive	Physical (unit)	6,699	6,349	5,584	18,632
A1.2	Replacement of networks/branch lines	Physical Network (km)	2	3	5	10
		Physical Branch Lines (unit)	171	204	391	766
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	729	729	729	2,187
A2	Leakage Survey	Physical (km)	912	912	912	2,736
A3.1	Leakage Repair in Network	Physical (unit)	1,561	1,545	1,530	4,636
A3.2	Repair of non-visible leakages (network)	Physical (unit)	182	182	182	546
A4.1	Sectorization (pressure zones)	Physical-project (unit)	4	0	0	4
		Physical-work (unit)	0	1	1	2
A4.2	VRP	Physical (unit)	0	2	3	5
A4.3	DMC	Physical (unit)	5	5	6	16
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	10	0	0	10
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	162	165	165	492
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	10,812	10,812	10,812	32,436
B2.1	Inactive inspections	Physical (unit)	10,183	10,183	10,183	30,549
B2.2	Irregularity Control	Physical (unit)	2,989	3,003	2,981	8,973
	UMA Installation	Physical (unit)	233	234	236	703
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	19,899	19,899	19,899	59,697
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	4	1	1	6
C2	Macrometer Calibration	Physical (unit)	48	48	48	144
C3	Capacity Building	Physical (unit)	38	19	19	76
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RN Loss Program aims to eliminate water meters older than 20 years. A major problem of this UN is fraud, which is committed by low-income population in municipality outskirts. Funds allocated to control of Real Losses during JICA Stage correspond to approximately 72% of the total allocated to RN and are mainly concentrated in actions for replacement of network and branch lines, and replacement of branch lines with leakage survey.

RN manages 4 municipalities, of which only 1 is considered as priority.

Some significant aspects:

- There is a plan to replace 68 km of network under the PROGRAM, 10 km of which during JICA Stage;
- Both the project and work implantation provide for 8 sectorizations for the whole PROGRAM, 6 of which during JICA Stage;
- Installation of 19 VRPs, 5 of which during JICA Stage;
- Plan for installation of 3 Boosters, none of which during JICA Stage;
- Plan for installation of 36 DMCs over 11 years of PROGRAM.

9-4-13 RR – Vale do Ribeira Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
Real Loss						
A1.1	Branch line replacement	Physical (unit)	5,805	5,747	5,690	17,242
A1.2	Replacement of networks/branch lines	Physical Network (km)	0	0	0	0
		Physical Branch Lines (unit)	0	0	0	0
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	749	749	749	2,247
A2	Leakage Survey	Physical (km)	949	949	949	2,847
A3.1	Leakage Repair in Network	Physical (unit)	1,451	1,437	1,422	4,310
A3.2	Repair of Non-Visible Leakages (network)	Physical (unit)	187	187	187	561
A4.1	Sectorization (pressure zones)	Physical-project (unit)	0	0	0	0
		Physical-work (unit)	0	0	0	0
A4.2	VRP	Physical (unit)	0	0	0	0
A4.3	DMC	Physical (unit)	3	5	4	12
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	2	20	5	27
Apparent Loss						
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	25	26	25	76
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	12,449	12,449	12,449	37,347
B2.1	Inactive inspections	Physical (unit)	13,504	13,504	13,504	40,512
B2.2	Irregularity Control	Physical (unit)	1,404	1,404	1,404	4,212
	UMA Installation	Physical (unit)	281	281	281	843
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	18,122	18,122	18,122	54,366
Management						
C1	Installation/Adequacy of Macrometers	Physical (unit)	9	4	2	15
C2	Macrometer Calibration	Physical (unit)	40	40	40	120
C3	Capacity Building	Physical (unit)	17	17	17	51
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RR comprises 23 municipalities, as systems components of UN. Its IPDt decreased from 253 l/(connections x day) in 2002 to 173 l/(connections x day) in June 2009. Funds to be allocated to Real Losses account for approximately 61% of total funds allocated to RR,

RR has not considered any municipally as priority and no network replacement is scheduled for JICA Stage.

Some significant aspects:

- There is a plan to replace 9 km of network under the PROGRAM, out of JICA Stage;
- There are currently 1,266 km of network and 90,000 branch lines, 61,993 of which are scheduled to be replaced over the 11 years of PROGRAM.
- No sectorization project or work is scheduled for the 11 years of PROGRAM.
- 2 VRPs will be installed during the transition period (2009-2010), without any Booster installation during JICA Stage;
- Plan for installation of 15 DMCs over 11 years of PROGRAM, 12 of which during JICA Stage..

9-4-14 RS – Baixada Santista Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
Real Loss						
A1.1	Branch line replacement	Physical (unit)	12,341	12,218	12,096	36,655
A1.2	Replacement of networks/branch lines	Physical Network (km)	11	11	11	33
		Physical Branch Li (unit)	900	900	900	2,700
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	3,291	3,291	3,291	9,873
A2	Leakage Survey	Physical (km)	4,113	4,113	4,113	12,339
A3.1	Leakage Repair in Network	Physical (unit)	5,892	5,833	5,775	17,500
A3.2	Repair of non-visible leakages (network)	Physical (unit)	823	823	823	2,469
A4.1	Sectorization (pressure zones)	Physical-project (unit)	1	0	2	3
		Physical-work (unit)	5	8	1	14
A4.2	VRP	Physical (unit)	4	4	7	15
A4.3	DMC	Physical (unit)	1	1	4	6
A4.4	Booster	Physical (unit)	1	1	1	3
A4.5	Slum closing	Physical (unit)	0,5	0,5	0	1
A5	Equipment	Physical (unit)	18	7	7	32
Apparent Loss						
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	1,126	1,139	1,139	3,404
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	58,636	58,636	58,636	175,908
B2.1	Inactive inspections	Physical (unit)	55,320	55,320	55,320	165,960
B2.2	Irregularity Control	Physical (unit)	15,033	15,033	15,033	45,099
	UMA Installation	Physical (unit)	3,007	3,007	3,007	9,021
B2.3	Slum regularization	Physical (unit)	0	736	736	1,472
B3	Record Update	Physical (unit)	42,952	42,952	42,952	128,856
Management						
C1	Installation/Adequacy of Macrometers	Physical (unit)	1	1	3	5
C2	Macrometer Calibration	Physical (unit)	190	190	190	570
C3	Capacity Building	Physical (unit)	15	15	15	45
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RS is considered the major R investment. Its problems are very similar to those in M units, in addition to have a seasonal population factor (floating population). During JICA Stage, 83% of RS funds will be allocated to actions against Real Losses, among which sectorization action is highly important, which account for 54% of funds allocated to RS.

RS manages 9 municipalities, 6 of which are considered as priority. It comprises currently 5,485 km of

networks and 429,510 connections.

Other important aspects of RS include:

- 117 km of networks are scheduled to be replaced under the PROGRAM, 33 km of which during JICA Stage;
- 34 sectorizations are planned (project and works) during the PROGRAM, 17 of which will be implanted during JICA Stage.
- Plan for installation of 33 VRPs throughout the PROGRAM, 15 of which during JICA Stage;
- 10 Boosters are planned to be installed over 11 years, 3 of which during JICA Stage;
- 11 DMCs are planned to be installed over 11 years, with a higher intensity after the sectorization scheduled for 2014.

9-4-15 RT – Baixo Tietê and Grande Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	10,067	9,966	9,866	29,899
A1.2	Replacement of networks/branch lines	Physical Network (km)	0	0	0	0
		Physical Branch Li (unit)	0	0	0	0
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	1,269	1,269	1,269	3,807
A2	Leakage Survey	Physical (km)	1,670	1,670	1,670	5,010
A3.1	Leakage Repair in Network	Physical (unit)	530	525	519	1,574
A3.2	Repair of non-visible leakages (network)	Physical (unit)	67	67	67	201
A4.1	Sectorization (pressure zones)	Physical-project (unit)	0	0	0	0
		Physical-work (unit)	0	0	0	0
A4.2	VRP	Physical (unit)	0	0	0	0
A4.3	DMC	Physical (unit)	12	17	10	39
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	0	0	0	0
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	0	0	0	0
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	23,149	23,149	23,149	69,447
B2.1	Inactive inspections	Physical (unit)	13,180	13,180	13,180	39,540
B2.2	Irregularity Control	Physical (unit)	2,104	2,104	2,104	6,312
	UMA Installation	Physical (unit)	84	84	84	252
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	10,522	10,522	10,522	31,566
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	11	9	11	31
C2	Macrometer Calibration	Physical (unit)	0	0	0	0
C3	Capacity Building	Physical (unit)	0	0	0	0
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RT IPDt is currently 117 l/(connections x day). This rate is relatively low as compared to other UNs, and is mainly due the application of the following actions: survey of non-visible leakages using a hearing rod, replacement of branch lines, rearrangement of old networks, continuous investigation of

frauds, and systematic replacement of water meters. In addition, minimum night outflow is controlled online in 15 municipalities accounting for 60% of volume produced in RT. There is a plan for implantation of that control in all its components and other 42 districts (rural suburbs), thus minimizing considerably the losses. In 95% of cases, maximum pressures are in the range of 15-50 mca. Its distribution lines older than 30 years do not exceed 50%.

RT manages 83 municipalities, none of which is considered as priority. It has currently 5,485 km of networks and 210,449 branch lines; there is no plan for network replacement during JICA Stage. Neither sectorization nor installations of VRP and Boosters during JICA Stage are scheduled. There is a plan for installation of 57 DMCs throughout the PROGRAM, 39 of which during JICA Stage..

9-4-16 RV – Vale do Paraíba Business Unit

(1) Estimated Quantities:

No.	Item		2011	2012	2013	Total
		Real Loss				
A1.1	Branch line replacement	Physical (unit)	23.126	22.894	22.666	68.686
A1.2	Replacement of networks/branch lines	Physical Network (km	33	33	33	99
		Physical Branch Lines (unit)	3.146	3.146	3.146	9.438
A1.3	Branch Line Replacement – Leakage Survey	Physical (unit)	2.371	2.371	2.371	7.113
A2	Leakage Survey	Physical (km)	3.293	3.293	3.293	9.879
A3.1	Leakage Repair in Network	Physical (unit)	2.570	2.544	2.518	7.632
A3.2	Repair of non-visible leakages (network)	Physical (unit)	263	263	263	789
A4.1	Sectorization (pressure zones)	Physical-project (unit)	0	0	0	0
		Physical-work (unit)	0	25	25	50
A4.2	VRP	Physical (unit)	8	6	6	20
A4.3	DMC	Physical (unit)	2	2	2	6
A4.4	Booster	Physical (unit)	0	0	0	0
A4.5	Slum closing	Physical (unit)	0	0	0	0
A5	Equipment	Physical (unit)	13	7	7	27
		Apparent Loss				
B1.1	Replacement of High-Capacity Water Meters	Physical (unit)	471	484	484	1.439
B1.2	Replacement of Low-Capacity Water Meters	Physical (unit)	53.303	53.303	53.303	159.909
B2.1	Inactive inspections	Physical (unit)	9.062	9.062	9.062	27.186
B2.2	Irregularity Control	Physical (unit)	1.945	1.945	1.945	5.835
	UMA Installation	Physical (unit)	**194**	**194**	**194**	**582**
B2.3	Slum regularization	Physical (unit)	0	0	0	0
B3	Record Update	Physical (unit)	46.673	46.673	46.673	140.019
		Management				
C1	Installation/Adequacy of Macrometers	Physical (unit)	20	20	20	60
C2	Macrometer Calibration	Physical (unit)	25	25	25	75
C3	Capacity Building	Physical (unit)	30	30	30	90
C4	Socioeducative Actions	Physical (unit)	-	-	-	-

Notes: Source – Sabesp – Physical-Financial Consolidation Schedule – May 2009

(2) Remarks:

RV serves 24 municipalities, and its IPDt has systematically decreased over the last years from 445 l/(connections x day) (June 2004) to 359 l/(connections x day) in June 2009.

RV is located in a highly developed region of the State of São Paulo and includes the main cities

between Rio and São Paulo, among which the city of São José dos Campos stands out, where is a high number of supply sectors with 3,000-3,500 connections; material and age of water distribution networks are adequate; it need the organization of non-visible leakage survey process, replacement of water meters and implantation of more sectors. Such actions also apply to other priority municipalities.

The estimated investment is the second higher investment of the whole R, and 73% of RV funds will be allocated to actions against Real Losses.

Out of 24 component municipalities, 5 are considered as priority and have 4,300 km of network and 388,939 branch lines, of which:

- 3,308 km of network belong to priority sectors; 364 km are scheduled to be replaced over 11 years, 99 km of which during JICA Stage;
- Fifty (50) sectorizations are planned (project and works) during the PROGRAM, all of them to be implanted during JICA Stage.
- There is a plan for installation of 60 VRPs throughout the PROGRAM, 20 of which during JICA Stage;
- There is a plan for installation of 3 Boosters throughout the PROGRAM. However, none of them is scheduled to be installed during JICA Stage.
- 20 DMCs will be installed over the period of 11 years, 6 of them during JICA Stage.

9-5 Drawings

Graphic representations of actions to be implemented during JICA Stage have been prepared, based on information provided by each UN, such as:

- Replacement of networks;
- Locations of VRPs, Boosters and Macrometers;
- Sectorizations.

We note that, for network replacement, the following information stands out:

- Location and course of networks;
- Type of material, diameter, length, etc.

All drawings are presented in a special volume that is part of this Report.

Chapter 10 Energy Optimization Program

10-1 Introduction

Under the energy optimization program prepared by Sabesp, the construction of two small hydroelectric power plants in Cantareira System and a small thermal power plant, the power generation plant powered by biogas from Barueri sewage treatment plant will be financed with Sabesp own funds, and have been therefore removed from the list of components indicated in the initial application. Studies and planning for power rationing in existing pump facilities will be financed by Sabesp own resources and implemented during JICA Stage, as provided in the initial application. t this stage, it was determined whether the contents of the power rationing plan in existing pump facilities, for example, are efficient to achieve the rationing target, and the appropriateness of the Power Optimization Program.

10-2 Optimization Plan for Facilities Under Study

Power optimization in 7 facilities indicated in Table 10-1 (5 water-related facilities and 2 sewage-related facilities) was indicated for its best adequacy to the power rationing plan and to the operational system. Figure 3-1 show the locations of such facilities.

Sabesp hired the firm VITALUX to develop the power rationing and operational system adequacy studies, including inspection and evaluation, cost estimate and economic analysis. The final report is scheduled to be delivered in January 2010.

Table 10-1 – Facilities and Optimization Plan

	Facility	Description of Facility and Current Conditions	Optimization Plan
1	Warehouse	Warehouse existing in Vila Prudente was constructed in 1979 to sell worn-out equipment and machinery It operated as Sabesp Central Warehouse, but is was deactivated after the company's structural reform. It occupies a total surface area of 6 hectares. Given the surrounding slum increase, it is necessary to improve the lighting system to prevent irregular invasion. This includes improved lighting using photomagnetic sensor system and automatic switches to control lighting hours and reduce electric power consumption. Such actions are necessary and sufficient. There is only 1 employee.	- Improvement in lighting system. - Investment of R$ 40,000.00.
2	Vila Medeiros Water Pumping Station	Water is collected from Guaraú Water Treatment Plant in the northern zone of São Paulo, and is distributed to high areas of Vila Medeiros through a ground reservoir. It was constructed in 1967. The ground reservoir is likely to be deactivated because it is located in a very high place. Currently, it operates consecutively with 3 motor pumps. Rotation should be controlled to reduce electric power consumption and increase the lifespan of motors and pumps. Current annual electric power consumption is 342.5 MW/h. After rotation control action, consumption will be reduced to 193.8 MW/h, resulting in an annual saving of 158.6 MW/h.	- Deactivation of ground reservoir. - Control of pump rotation (action for adjustment to water pressure variation in piping) - Investment of R$ 500,000.00.

	Facility	Description of Facility and Current Conditions	Optimization Plan
3	Guaramiranga Sewage Pumping Station	ABC intermediate sewage treatment plant. It was constructed in 1998. After elimination of larger and sand impurities, sewage goes through the gauze and sand box to ABC sewage treatment plant. There are currently 3 lift pumps. Upon replacing the reducer, coupling and motor of old pumps, electric power consumption will be reduced. Current power consumption is 51,139 kW/h, which would be reduced to 46,674 kW/h after the replacements referred to above. This would mean a monthly electric power saving of 4,816 kW/h.	- Replacement of reducer, coupling and motor lift pump. -Investment of R$ 300,000.00.
4	São José Pumping Station (*Booster Pump)*	*Booster Pump* Station is located in Suzano. It normally operates unattended. It was constructed in 1999 and serves a population of 77,000 inhabitants. There are 3 Boosters. Those are new pumps that require no replacement. Control of distribution pump rotation according to network pressure will be sufficient to reduce electric power consumption. Discharge volume of Booster Pump is 400 m^3/h.	- Control of *booster pump* rotation. - Investment of R$ 500,000.00.
5	São Miguel Sewage Treatment Plant.	Sewage treatment plant for organic sludge constructed in 1998. It serves 642,750 inhabitants. Planned treatment volume is 129,000 m^3/day (from April 2008 to March 2009 it had an average treatment volume of 79,000 m^3/day).	- Improvement of aeration system.
6	Rio Grande Water Pumping Station	Pumping Station that conveys water from Billings dam to Rio Grande Water Treatment Plant. It serves a population of 1,400,000 inhabitants. Total volume of water conveyed to the treatment plant is 4.7 m^3/sec (406,080 m^3/day).	- Evaluation of chemical composition system (NaOCℓ, KMnO4). - Examination of water piping use.
7	Guarapiranga Water Pumping Station	Pumping Station that conveys water from Guarapiranga dam to ABC Water Treatment Plant. In addition to facilities for water storage and chemical treatment, sand box, and pumping station, there is booster pump that collects water from ABC ETA, work shop, storehouse, etc. Population served by ABC ETA amounts to 3,700,000 inhabitants. Volume conveyed to ETA is 14 m^3/sec (1,209,600 m^3/day). Real Result.	- Cleaning of nozzle impurities. - Investigation of effect of sloping sand box plates. - Improvement in lighting system of building..

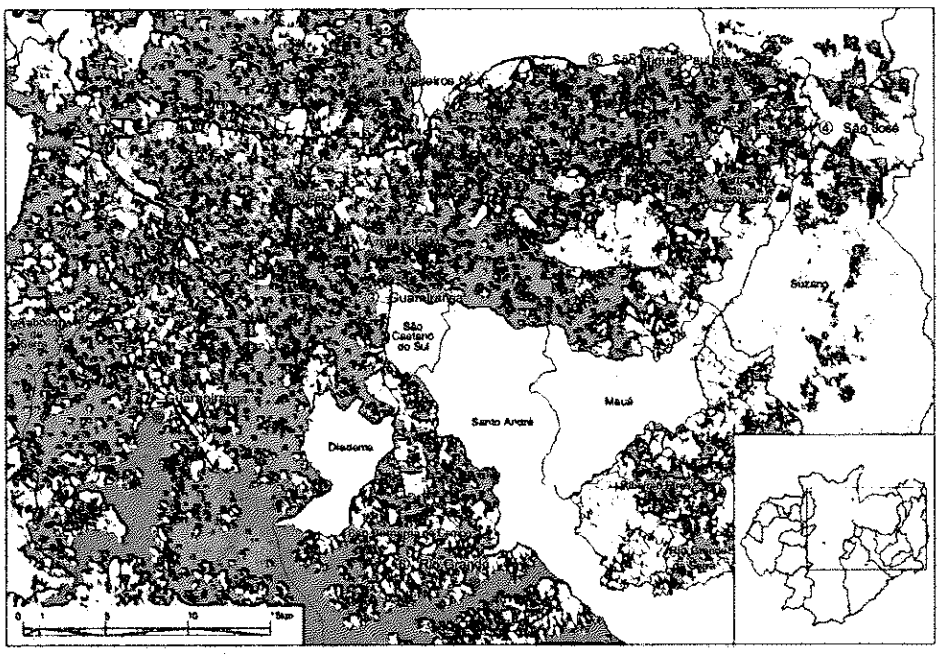


Figure 10-1 Site Map of Facilities

10-3 Result of Optimization Studies

(1) Warehouse

Internal lighting in 4 buildings comprising the control room, maintenance room and 2 storehouses, in addition to external lighting.
Of those 4 buildings, the only currently in use is the control room. This way, study for electric power reduction was restrict to control room and external area lighting.

After checking the lighting devices, transformer and lamps, it was concluded that the required investment in improvements amounts to R$ 171,134.00. The Internal Rate of Return (IRR) is -1.7%, which does not justify its application.

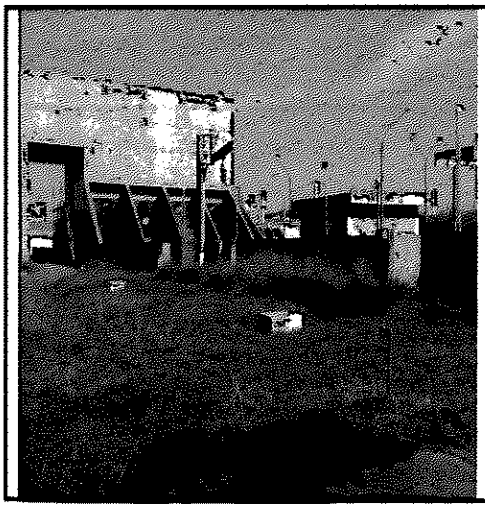
(2) Vila Medeiros Water Treatment Plant

Given the adoption of rotation control system according to the internal water piping pressure, it is possible to deactivate the ground reservoir and thus reduce the electric power consumption;

- Installation cost: R$ 495,000.00
- Electric power reduction: 179,000 kW/h/year
- Cost of electric power reduction: R$ 45,807.64 per year.

- Internal Rate of Return (IRR): 8%

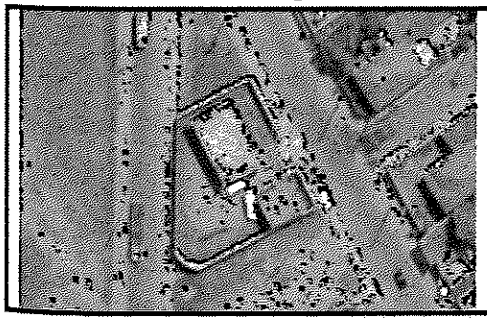
(3) Guaramiranga Sewage Pumping Station



Result of evaluation of water collection pump system (lift pump):
(1) Replacement of reducer, motor and coupler will not result in a significant different, as it reduces negligibly the electric power consumption.
(2) By changing to current continuous operation system to on-off system activated by intake water level, electric power consumption may be reduced.

- Installation cost: R$ 288.852.22
- Electric power reduction: 4,916 kWh/month
- Cost of electric power reduction: R$ 15,337.56 per year.
- Internal Rate of Return (IRR): Under analysis by Sabesp
- Cost of installation: Under analysis by Sabesp

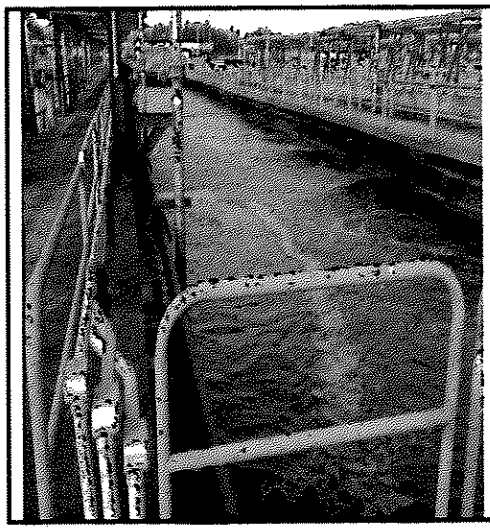
São José Booster Pump Station



Electric power reduction is possible by controlling the booster pump rotation based on the internal piping pressure.

- Cost of installation: R$ 465,500.00
- Electric power reduction: 492,000 kWh/year
- Reduction of electric power cost: R$ 105,481.00/year
- Internal Rate of Return (IRR): 23%

(5) São Miguel Sewage Treatment Plant



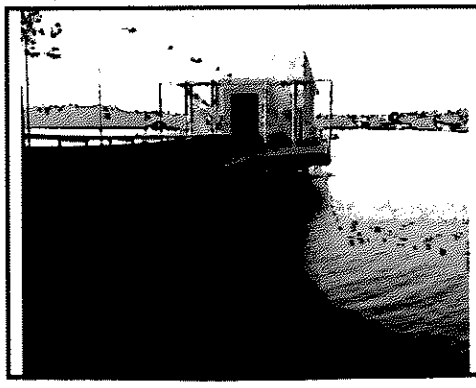
There are 2 blowers installed in the aeration center and sand box. Current status: BOD – Biochemical Oxygen Demand in this station is 47 mg/L . The possibility of blowing air in the sand box using the excess of power of aeration tank blower and switching off the sand box blower was evaluated.

- Cost of installation: R$ 416,877.00

(Ventilation is necessary to remove sand box sludge during the preparation to measure sand box air volume.)

- Reduction of electric power cost: Under analysis by Sabesp
- Internal Rate of Return: Under analysis by Sabesp

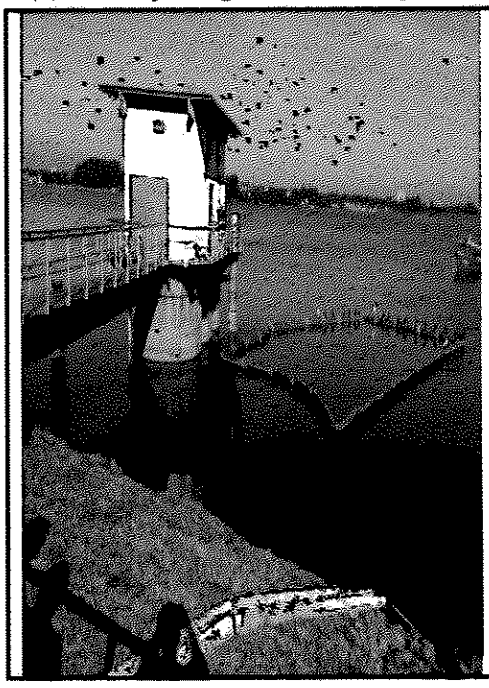
(6) Rio Grande Water Pumping Station



- Evaluation of chemicals composition (evaluation of electric power consumption reduction in case of use of KMnO4, NaOCℓ currently not used.
  Effect of chemicals on high discharges has not been fully evaluated. However, as water quality in Rio Grande dam has improved, it is assumed that is better to avoid using that substance.

- Regarding the proposed simultaneous use of piping currently used and the deactivated of pipeline, analyses indicate that that simultaneous use is not adequate.

(7) Guarapiranga Water Pumping Station



- Studies for removal of material accumulated near the nozzle.
  The several processes for removal of material accumulated in nozzle should be better evaluated taking into account the high operation discharge. This way, there are still doubts about the process that would be most effective. Consequently, that process was not considered in this optimization project.

- Determination of effect of sloping sand box plates.
  After measurement of suspended solids, it was noted that there was no difference between the front and back parts of sloping plates, what did not identify its efficacy. As such, such plates may be removed.
- Improvements in lighting system of internal building area.
  Electric power consumption could be reduced by replacing existing lamps for more economic lamps.
- Cost of investment: R$ 197,201.00.
- Volume of electric power reduction: 241.542 kWh/year
- Cost of electric power reduction: R$ 53,537.09 per year.
- Internal Rate of Return (IRR): 21%.

Table 10-2 – Results of Optimization Program Studies

	Facility	Result	Estimate
(1)	Warehouse	The feasibility of a proposal for improvement of internal lighting of control room was considered, but IRR was negative and made it impracticable.	- - -
(2)	Vila Medeiros Water Pumping Station	It is possible to save electric power by controlling the rotation speed of water pump. Volume of electric power reduction: 179,000 kWh/year.	Cost of installation: R$ 495,000.
(3)	Guaramiranga Sewage Pumping Station	It is possible to save electric power by operating the water collection pump in on-off mode.	Cost of installation: R$ 288.852.
(4)	São José Pumping Station (Booster Pump)	It is possible to save electric power by controlling the speed of pump (booster pump). Volume of electric power reduction: 492,000 kWh/year.	Cost of installation: R$ 465.500.
(5)	São Miguel Sewage Treatment Plant.	It is possible to direct air to the sand box through the aeration tank blower by switching off the sand box blower.	Cost of installation: R$ 416,877.
(6)	Rio Grande Water Pumping Station	It will not be necessary to inject chemicals (KMnO4, NaOCℓ) There no credit in the proposed simultaneous use of the old pipeline.	- - -
(7)	Guarapiranga Water Pumping Station	• It is difficult to detect the effect of impurity removal from the nozzle. • Sloping sand box plates are unnecessary. • Internal lighting. It is possible to save electric power.	Internal illustration. Cost of investment: R$ 197,201.
		(2), (3), (4), (5), (7) **TOTAL**	**R$ 1,863,430.**

10-4 Comments and Suggestions

(1) After energy efficiency studies in 7 locations proposed by Sabesp, it was concluded that, except for warehouse and Rio Grande Water Pumping Station, optimization is valid in all other locations and should be implemented.

(2) As we can learn from such studies, control of pump speed according to pressure variation inside the piping derived from water use variation is efficient. (Vila Medeiros Water Pumping Station and São José Booster Pump Station).

This electric power rationing method has been applied in Japan for some decades. In addition to reducing to costs of electricity, it will prevent excessive pressure and water leakage.

(3) Such studies have a limited target, but in Sabesp there is a high use of electricity in pumping areas (approximately 5,000 municipalities, 11 of which are supplied with 88-kV low voltage power, some 1,000 municipalities are supplied with 13.8-kV medium voltage power by concessionaires, and all others are supplied with 220-V power. Thus, there are several locations with possibilities of