When things go wrong: an oversight in one of the arrows can overturn the result of years

D Soares(1), G A Carvalho(2), F L Denapoli(3), E Patella(4), F Paracampos(5)

(1)Sabesp, Rua Dona Antonia de Queiros 218, Sao Paulo, SP, 01307-010, Brazil (email: dsoares@sabesp.com.br)
(2)Sabesp, Rua Dona Antonia de Queiros 218, Sao Paulo, SP, 01307-010, Brazil (email: genvialcarvalho@sabesp.com.br)
(3)Sabesp, Rua Dona Antonia de Queiros 218, Sao Paulo, SP, 01307-010, Brazil (email: fdenapol@sabesp.com.br)

(4)Sabesp, Rua Sumidouro448, Sao Paulo, SP, 05428-010, Brazil (email: epatella@sabesp.com.br)

(5)Sabesp, Rua Sumidouro 448, Sao Paulo, SP, 05428-010, Brazil (email: paracampos@sabesp.com.br)

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Abstract

The solution to reducing and sustaining leakage rate in a defined economic level is rather different in utilities around the world. However, the need for the best possible reduction in leakage up to a level compatible with a given OPEX, taking into account the CAPEX applied to apply to any particular problem over short, medium and long term time horizons can be very complex.

For years Sabesp has been working heavily on three of the four key tools to reduce real losses, namely decreased response time for repair of reported leaks, more frequent active leakage control (detection and repair of unreported leaks) and pressure management, and achieved very good results with a constant decrease in annual water loss and an increase in the efficiency operation. However these actions alone are not sufficient for a sustainable longer term target.

A significant part of the maintenance of the distribution networks is outsourced, and a number of problems were faced last year, which consequently, overturned the positive results of years in loss reduction.

This paper will focus on the lessons learned and results obtained in the Central Business Unit of Sabesp, exploring how an oversight in one of the arrows (speed and quality of repairs), in a scenario where the infrastructure is weak, can overturn the positive result of years as well as the importance of proper management the outsourcing of essential services.

Introduction

The Metropolitan Region of Sao Paulo (MRSP) has 19 million inhabitants settled in 800 km². The landscape is mountainous, varying from 730 to 850m above sea level. The Water and Sanitation Company of the State of São Paulo (Sabesp) supplies water and sanitation services through a distribution network of 29,500 km of mains, with 3.6 million connections for their customers, and bulk sales to six municipalities. The water system is fully metered and consumers have individual building storage tanks. The distribution network of MRSP is split into 5 business units, and this work will present a case study applied in the Central Business Unit.

The Central Business Unit includes the downtown area and the expanded part of the eastern city of Sao Paulo, where there is a great social-economic diversity. It has a land area of 281 km^2 and a population of about 3 million inhabitants. However for covering much of the consolidated urban sprawl, its main feature is the floating population of 1.3 million people per day.

The Central Business Unit has the following characteristics:

- 726,000 active connections
- 1,482,000 properties
- 5,850 km of distribution mains
- 109 km of transmission mains
- 14 booster stations
- 30 bulk supply zones
- 217 pressure controlled districts covering around 55% of the network
- Average pressure of 45 meters head

The infrastructure of the Central Business Unit is the oldest in the MRSP. About 73% of distribution mains are more than 30 years old. This makes real losses being a predominant problem in Central Business Unit (about 62% of total).

Sabesp has been applying International Water Association (IWA) best practice since 2002 and is an active member of the IWA and the water loss task force. For several years Central Business Unit has been working on three of the four key tools (Figure 1) to reduce real losses namely decreased response time for repair of reported leaks, more frequent active leakage control (detection and repair of unreported leaks) and pressure management. A little has been done to replace faulty infrastructure, since the investments needed are relevant. As an average of 0.3% of the pipe are replaced yearly and 30 % of service connections has already been replaced.

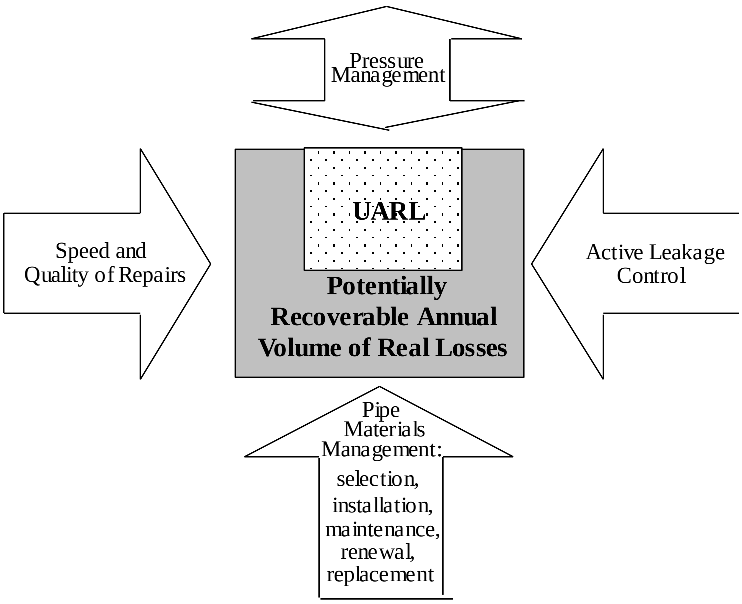

Figure 1 - Four key tools to reduce real losses (THORNTON, 2002).

The strategy of postponing investments in infrastructure replacement, when its lifetime is expiring defines a risk for water loss performance. In fact, an additional effort must be allocated in fixing leaks fast and properly, probably touching the cost/benefit limit of the action, for maintaining a certain level of result if just one arrow is worked out.

Thus, this paper will focus on the lessons learned and results obtained in the Central Business Unit of SABESP, exploring how an oversight in one of the arrows (speed and quality of repairs), when you have a weak infrastructure, can overturn the positive result of years as well as the importance of properly management the outsourcing of essential services in loss reduction.

Methods for Reducing Real Losses: Adopted Strategies

The adopted strategy involves all four arrows for reducing real losses as seen in Figure 1, although different strengths has been applied and there is a defined budget for all kinds of interventions. A detailed component analysis cost and benefits analysis over the short, medium and long term perspectives provided some directives for the managing decisions (PARACAMPOS et al, 2009).

Actions to reduce real loss had been developed with an increasing pace along the years in Central Business Unit - Sabesp, as seen in Table 1. However, in 2010 a low performance in the outsourced maintenance contract came up, besides an increasing time to fix the leakage and consequently rose up the lost volume.

Table 1 – Actions to reduce real losses in Central Business Unit along the years.

Actions to reduce real losses along the years	**2008**	**2009**	**2010**
Installed PRVs (units)	10	10	5
Active leakage control (surveyed length in kilometres)	5,321.2	4,903.2	5,335.0
Repaired leaks (units)	84,761	81,481	71,482
Average time to repair leaks (hours)	13.9	21.9	**30.2**
Service connection replacements (units)	40,163	28,218	21,358
Main replacements (kilometres)	19.5	19.5	11.9

The water balance along the years below (Table 2 and Figures 2 and 3) can provide some fairly idea about volumes recovered/action, using the arrows as references for three years.

Table 2 – Water Balances in millions of m^3.

Annual volume in millions of m^3	**2008**	**2009**	**2010**
System input	419.5	416.7	440.9
Authorised consumption	308.7	313.2	322.4
Total water losses	110.8	103.5	**118.5**
Apparent losses	43.0	43.1	44.9
Real losses	67.8	60.4	**73.6**

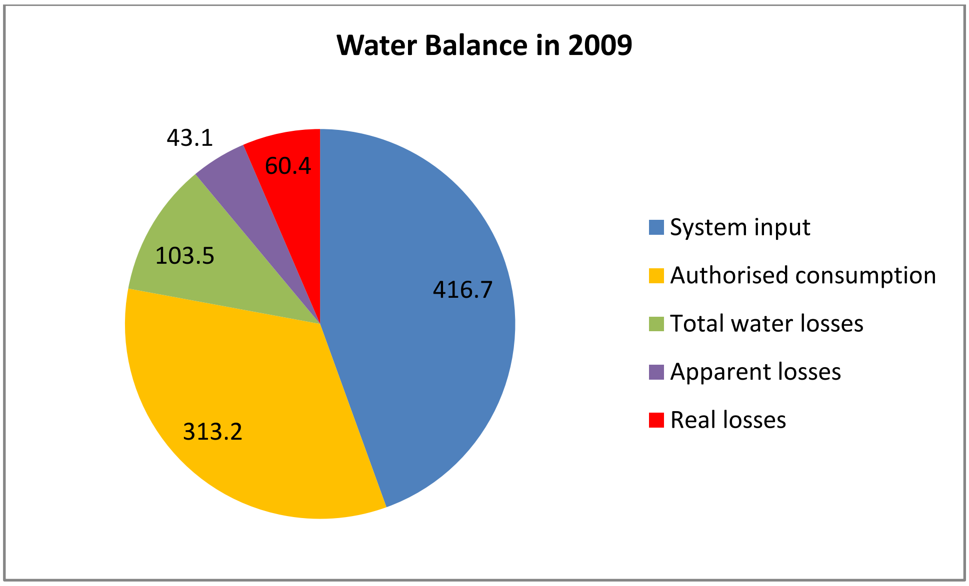

Figure 2 – Central Business Water Balance in 2009 (millions of m^3).

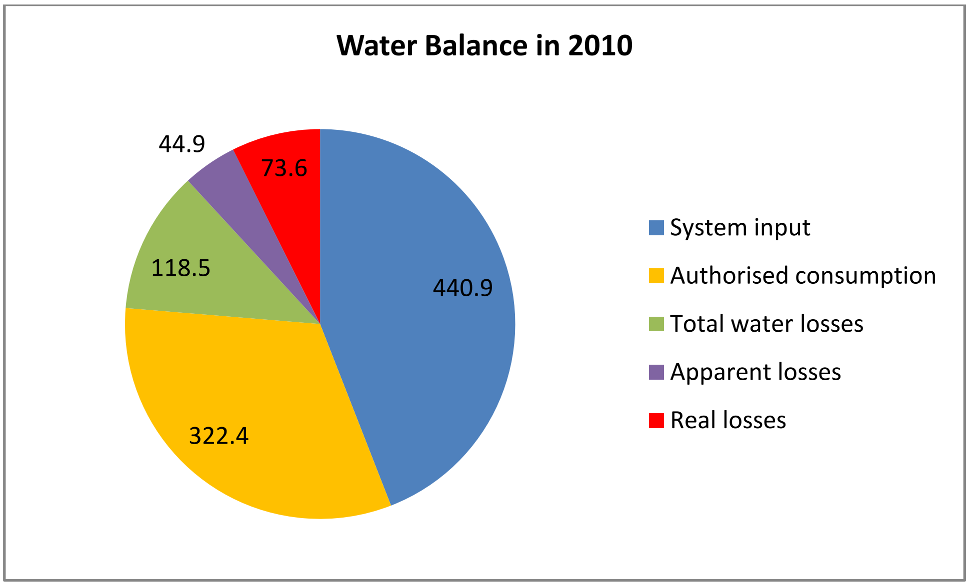

Figure 3 - Central Business Water Balance in 2010 (millions of m^3).

It is briefly presented the adopted strategies and the faced tackled problems for reducing real losses in Central Business Unit along the recent years.

Pressure Management

Although a significant amount of pressure control has been done within Sabesp over the last fifteen years, it is still a key action for controlling losses furtherer, since it has positive effects on all of the components of real loss as seen in Figure 2.

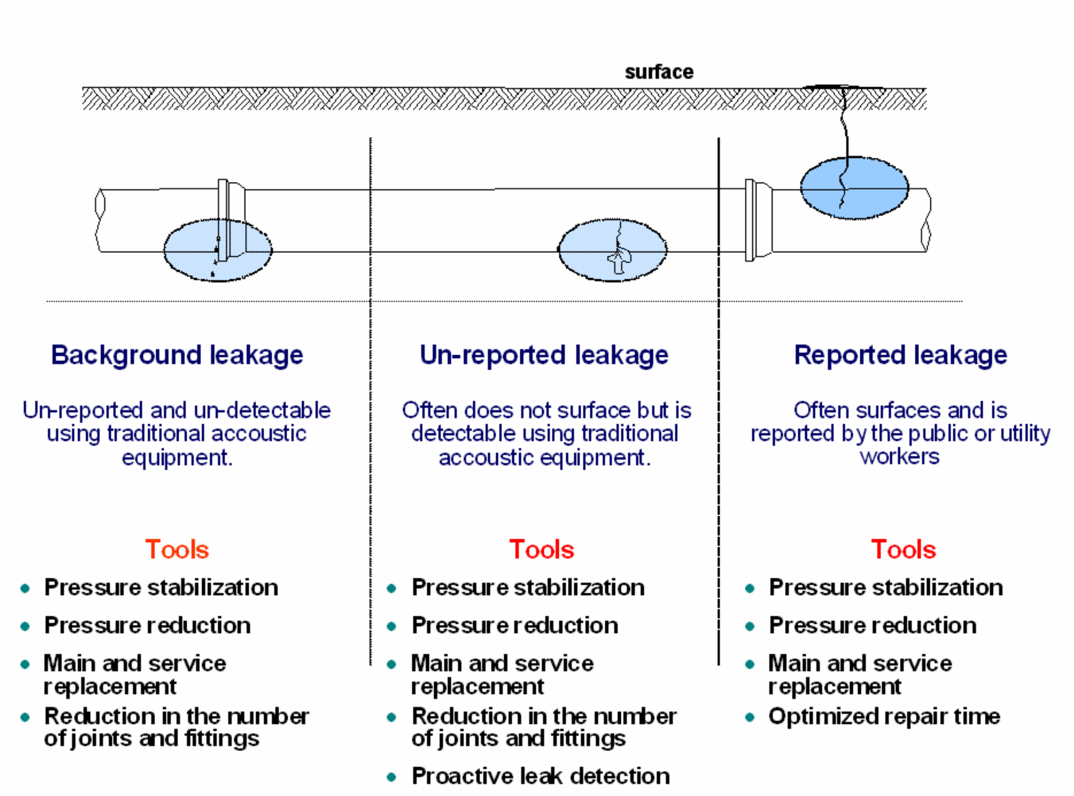

Figure 4 – Components of real loses and tools for intervention(adapted from TARDELLI, 2004)

Since the first PRV was installed in Central Business Unit in 1997, up to now, 217 PRVs were installed; regulating pressure in about 54% of the distribution network (SABESP, 2011) and the major achievement is the reduction of 50% in the break frequency within the protected areas. The adopted strategy on PRVs has changed over time since the very first operation rule, fixed outlet, electronic controllers modulated by time or flow, hydraulic switchers with two levels of output pressure (two set points); and nowadays, the latest strategy adopted since 2009 is to install PRVs at the exit of reservoirs or entry of supply zones, reducing less pressure head, but actually affecting the entire extension of the supply zone (MELATO et al, 2010). The concept is the current failure rate is comparatively high, and then quite a small reduction in pressure may produce a large reduction in burst frequency and may extend infrastructure life (THORNTON, STURM, KUNKEL, 2008)

The first valves were installed through outsourced contracts, but nowadays the PRVs are all installed with totally Sabesp´s team, from design to construction project and pre-operation, even for large diameters, as seen in Figure 3.

Figure 5 – Installation of a 400 mm PRV by Sabesp´s labour (Source: Sabesp).

The average savings for a PRV installation in the last years were about 6.15 L/s (the minimum night flow reduction), just as reference for comparison with other actions.

Active Leakage Control

Leak detection is carried out in areas with high volumes of unreported leaks and where service pipe break frequency is not considered critical enough that they will be changed out. An average of 70% of the length extension of mains is surveyed each year using ground microphones and leak noise correlators, districted metered areas (DMAs) and the Geographic Information System (GIS) to direct the leak detection surveys (PAIXAO et al, 2010).

This service is basically outsourced and there is a small Sabesp´s team supervises the entire activity and besides that conducts special surveys when necessary.

A logical and flexible approach to assessing the average duration of reported and unreported leaks is to consider three separate components: awareness (A), location (L) and repair (R), (LAMBERT *et al,* 1998).

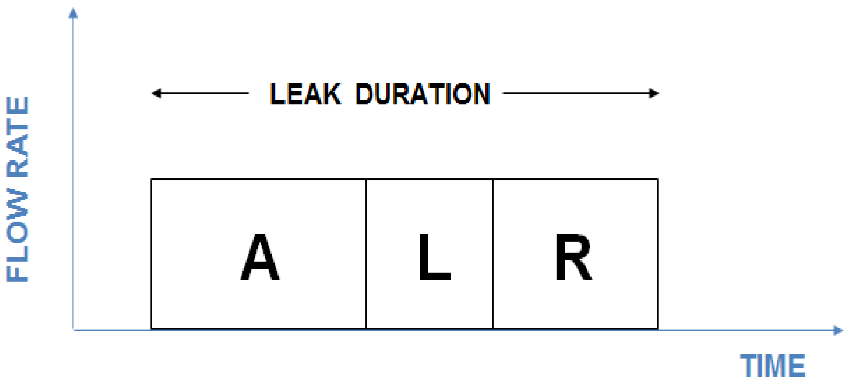

Figure 6 – Volume lost from a leak.

During the last year, as seen in Table3, a significant increase in the repair phase (R), for both reported and unreported leaks, caused an augmentation in total lost volume, and we considered this as the principal contribution of the degradation of water losses indicator and for the increasing of 13.2 million of m^3 in the annual volume of real losses from 2009 to 2010 according to Table 2.

Table 3 – Leak run time phases in days in Central Business Unit along the years.

Time (days)	Awareness		Location	Repair
	reported	unreported		
2008	3	230	< 1	< 1
2009	3	209	< 1	< 1
2010	3	228	< 1	15
2011	3	230	< 1	< 1

Through a detailed Background and Bursts Estimates (BABE) Component Analysis (LAMBERT, 1997), it is possible to estimate a total volume of 8.8 million of m^3/yr, a relevant part of lost volume indicated in the 2010 water balance, due to such delay in fixing leaks. The other 4.4 million of m^3 were possibly lost due to the reducing of other actions (installation of new pressure reducing valves, service connections replacement and rehabilitation of mains) and consequently to the natural rate of rise.

Infrastructure Management

Only a little of mains have been replaced in Central Business Unit, about 20 km per year, less than 0.3% of the whole extension. Sabesp has recently agreed a funding with Japan Cooperation Agency (JICA) to reinforce the mains replacement program and it is projected benefits from this action from 2013.

Nowadays, it is expected to give more emphasis on service connections replacement, which also impacts all three of the real loss components. However, as it is a costly action, it has only been adopted in weak parts of the system where break frequencies are very high. To develop this action, GIS maps are also used (PAIXAO et al, 2010).

So far, although a number of service connections replacement have already been made from 2005 (about 30%)and it is projected to replace up to 60% of the total, since the new connection made in new developments are using new materials and are properly made.

This connection replacement service is outsourced and there is a small Sabesp´s team that supervises the activity and conducts some critical replacements.

The savings for a service connection replacement is about 13.2 L/h/connection replaced in areas covered by PRVs and 29.2 L/h in areas not covered by PRVs (CARVALHO, MELATO, 2007), just as reference for comparison about gains with other actions.

Speed and Quality of Repairs

The current location and repair time for fixing leakage used to be reasonable; it was currently less than one day, because it is not cost effective to have a faster location and repair time, since the volume saved through increased effort is not relevant.

This work is outsourced and comprises mains, connections leak repairs.

Since 2004 Sabesp has been made an outsourced contract named “Global Sourcing Services”, which includes all the maintenance services (water and sewage) with one only company, which allows time savings in the bidding process and a better management, because all services are in charge of one single company.

However, as early mentioned, in 2010 a problem of discontinuity in this outsourced contract, increased the time for maintenance was (Figure 4), moving from less than to 20 hours to an average more than 120 hours (in some supplying zones it increased to more than 230 hours, almost 10 days). Such change in the level of service provoked a high increase in total volume lost and has put more light in the need of replacing the whole infrastructure.

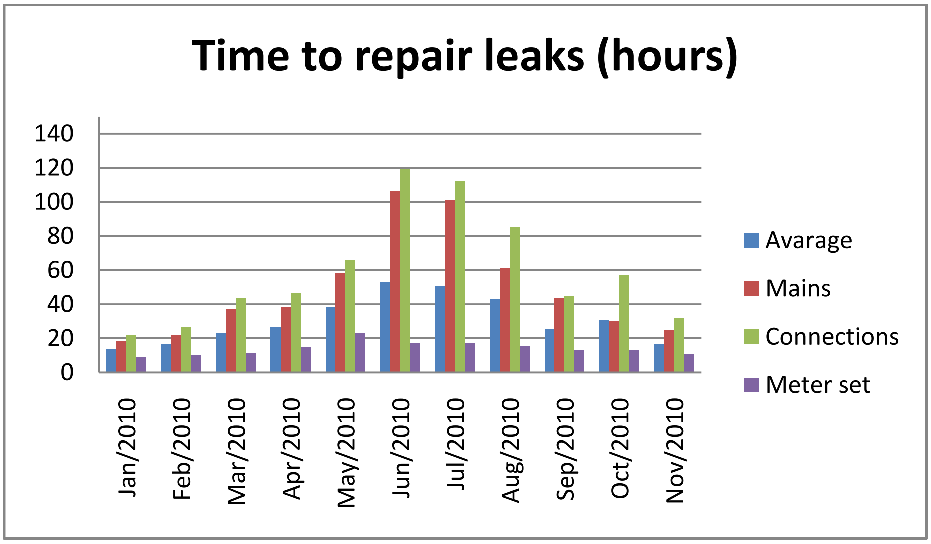

Figure 4–Time to repair leaks in hours in 2010**.**

Results and Discussion

With all these efforts to reduce real and apparent losses, Central Business Unit had been constantly reducing the losses indicators along the years. The process indicator for total water losses average reduced from 659 L/conn/day in 2003 to 397 L/conn/day in 2009, and the metric indicator for real losses - ILI reduced from 8.5 in 2006 to 5.3 in 2009, as it can be seen in Figures 5 and 6.

But in 2010 the problem of discontinuity in the service contract for leak repair, which is outsourced, overturned the positive results of years in loss reduction in Central Business Unit. In 2010 the process indicator for total water losses average increased to 454 L/conn/day and the ILI to 7.8.

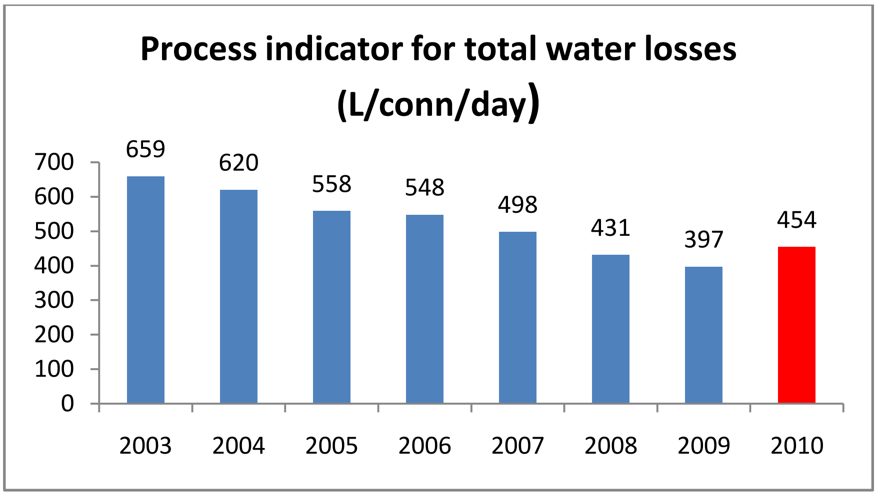

Figure 5 - Process indicator for total water losses (L/conn/day).

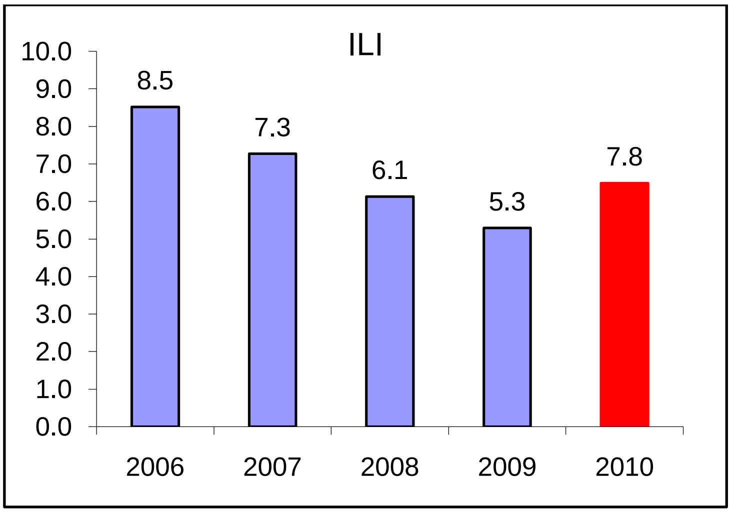

Figure 6–Infrastructure Leakage Index – ILI.

These problems occurred owing to a decrease in the provision of services for leak repairs, because there was a reduction in manpower due to the discontinuity of the outsourced contract.

This increased the time to repair leaks as seen before in Figure 4 and it became necessary to shift own manpower from the maintenance staff for make these services, thus reducing also other actions to reduce real losses, such as installation of new pressure reducing valves, service connections replacement and rehabilitation of mains.

So the problem with the outsourced maintenance contract increased the time to repair leaks, therefore increasing the lost volume, but it also impacted on reducing the pace of the real losses actions due to relocation of the staff, contributing further to increase the losses.

Only now, almost six months after the outsourced contracts came back to normal, the time to repair leaks returned to a value of less than one day, as well as other actions to reduce real losses are also returning to the normal pace, it is noticed that the water loss indicator has stabilized and decreased in some supplying zones, as such as Alpina Village supply zone (MIGUEL *et al*, 2012).

Conclusions

The solution to reducing and sustaining water distribution system leakage to economic levels is different in utilities around the world, however the need to be able to reduce leakage and identify the correct levels of operating and maintenance budget versus capital investment to apply to any particular problem over short, medium and long term time horizons can be very complex.

For several years Sabesp has been working on three of the four key tools to reduce real losses, namely decreased response time for repair of reported leaks, more frequent active leakage control (detection and repair of unreported leaks) and pressure management and has achieved very good results with a constant decrease in annual water loss and an increase in efficient operation. However these actions alone are not sufficient for a sustainable longer term target, because only a little has been done to replace faulty infrastructure, since the investments needed are very expensive.

A problem of discontinuity in the service contract for leak repair in 2010, which is outsourced, overturned the positive results of years in loss reduction in Central Business Unit of Sabesp. Only now, almost six months after the outsourced contracts came back to normal, it is noticed that the water loss indicator has stabilized and decreased in some supplying zones.

The lessons learned are that an oversight in one of the arrows (speed and quality of repairs), when you don´t have an infrastructure good enough, can overturn the positive result of years as well as the importance of properly management the outsourcing of essential services in loss reduction.

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