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APPLICATION OF THE IWA METHODOLOGY TO REDUCTION WATER LOSSES IN SUPPLY SYSTEMS IN THE EAST REGION OF MINAS GERAIS

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Abstract: The topic of Water Loss in Supply Systems has become increasingly relevant in recent decades, mainly due to the increased frequency of water scarcity events.
Another preponderant factor for the increased attention on this topic is from an economic and financial point of view, with issues related to the high costs of electrical energy used in the production and distribution of treated water and the waste of natural, operational and revenue resources.
This way, structuring actions and an Action Plan for assessment, control and reduction of losses are essential, consistent, continuous and effective to achieve significant results in reducing water losses.
For this purpose, the International Water Association (IWA) recommends the use of the water balance methodology to diagnose losses in the water distribution system.
Using this methodology, losses are divided into apparent and real. This distinction is important, as the tools for managing and combating each of the typologies differ substantially.
In this context, the present work presents the improvement in the performance of water loss management with the effective achievement of results in reducing losses in the region covered by the East Business Unit, operated by Companhia de Saneamento de Minas Gerais, based on the use of the techniques and methodologies proposed by renowned institutions that deal with the topic of Water Loss in Distribution, associated with the application of innovative technologies with cost/benefit compatible with the economic condition of the System.
The results achieved confirm that it is possible to control and decrease the loss rate through the development of integrated actions at the strategic and operational levels of governance, based on the tools proposed by IWA and respecting local realities.

Keywords: Water loss, Supply System, Water Balance, IWA, Action Plan.

INTRODUCTION

According to the National Sanitation Information System (SNIS) 2020, losses are inherent to any water supply system. This topic has gained greater relevance in recent decades, mainly due to the increased frequency of water scarcity events. Furthermore, from an economic and financial point of view, there are also issues related to the high cost of electrical energy used in the production and distribution of treated water and the waste of natural, operational and revenue resources.

As the costs arising from losses are passed on to the final consumer, the human right to access drinking water, recognized by the United Nations, and the principle of universal access to basic sanitation services, established by Law No. 14,026/2020, can be harmed. In this scenario, structuring actions and an Action Plan for continuous and effective assessment, control and reduction of losses are essential.

In order to reduce water losses, the International Water Association (IWA) recommends the use of the water balance methodology to diagnose losses in the water distribution system. In this methodology, losses are divided into apparent and real. This distinction is important, as the tools for managing and combating each of the typologies differ substantially.

As Water Loss is one of the risks inherent to the business of sanitation companies, in 2020, Companhia de Saneamento de Minas Gerais – COPASA MG, structured an action plan in order to consolidate actions to combat losses for the Eastern region of the State of Minas Gerais, covering at the time 641,482 water connections operated across 6,098,863 meters of distribution network. The prioritization of actions was preceded by a critical analysis

of the lost volumes and characteristics of the locations covered, in order to guarantee the effective reduction of losses.

It is important to highlight that the training of the team involved, the search and application of accessible innovative technologies, in line with conditions and needs, and with cost/benefit appropriate to local realities, were points of high relevance for the significant reach in reducing the rate of losses.

WORK OBJECTIVES

Demonstrate the improvement in the performance of water loss management, by COPASA MG, in the eastern region of Minas Gerais, based on the use of techniques and methodologies proposed by renowned institutions that deal with the topic of Water Loss in Distribution, associated with the application of technologies innovative solutions with cost/benefit compatible with the economic condition of the Supply System.

Analyze data from the most relevant Water Supply Systems - SAA, among the 222 operated by COPASA MG within the scope of the five Regional Managements of the East Business Unit - UNLE, which assume for themselves the names of the Municipalities where their headquarters are located, then the Managements of Almenara - GRAL, Caratinga - GRCA, Diamantina - GRDT, Ipatinga - GRIP and Teófilo Otoni – GRTO.

Confirm that the effective control and decrease in the loss rate is the result of the development of integrated actions at the strategic and operational levels of governance, based on the tools proposed by IWA.

METHODOLOGY USED

The model used to diagnose the water loss rate was the Water Balance, following the concepts expressed in the literature of the Brazilian Association of State Sanitation Companies (AESBE) and the International Water Association (IWA), whose tool aims to identify, through from a mathematical equation, the volumes of real losses, apparent losses and water not converted into revenue (ANCR).

In the initial phase, the Water Balances of COPASA, UNLE and their five Regional Managements were calculated, whose results presented indicated that real losses were the main responsible for the loss rate, reaching the level of 70% in relation to the total lost volume.

As a starting point, historical data on annualized lost volume (m^3/year) by Supply System was then studied, with the results being a relevant factor in deciding on the prioritization of actions.

Since the diagnosis phase and throughout the development of the Loss Reduction Action Plan, the annualized loss indicator in liters per connection per day was adopted, that is, to calculate the indicator, each month uses the sum of volumes of the 12 last months and the number of days accumulated in the period, the unit being L/lig/day.

Figure 1 shows the impact of the annualized lost volume in percentage, of UNLE in relation to COPASA, with this Unit being responsible for 11% of the Company's total lost volume. In a similar way, the impacts of lost volumes from Regional Managements to UNLE are also presented, where GRIP has the greatest impact with approximately 59% of the Unit's total lost volume, and the other Managements varies between 6% and 14%.

All results presented are annualized and refer to the period January to December 2019.

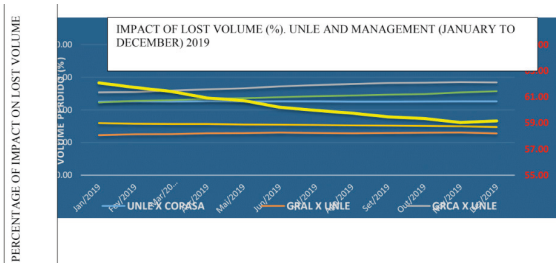

Fig 1 – Impact Lost Volume UNLE and Management (%)_2019

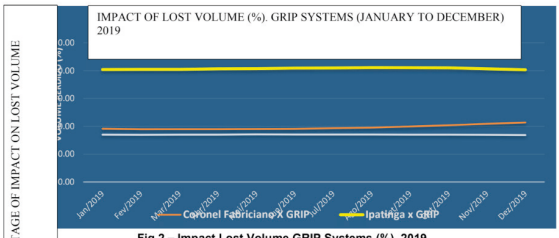

Fig 2 – Impact Lost Volume GRIP Systems (%). 2019

Due to the relevance presented by GRIP for the UNLE Distribution Loss indicator, with approximately 59% of the Unit's total lost volume, the behavior of the Loss indices of the Supply Systems of this Management were also studied, with Coronel Fabriciano's Systems being confirmed., Ipatinga and Timóteo as the main potential for developing the Action Plan to be implemented at UNLE. It is interesting to highlight that these three are the largest GRIP Systems and are located in the Metropolitan Region of Vale do Aço. It is worth mentioning that an aspect of interest in the Metropolitan Region of Vale do Aço was the fact that the operational teams, especially in the SAA of Ipatinga and Timóteo are already carrying out research on non-visible leaks, presenting, in addition to its relevance, in relation to Management, a downward trend in lost volume, but still inconsistent due to the lack of integrated management with other activities necessary to control and reduce losses in distribution.

Figure 2 shows the impact, in percentage, of the lost volumes of the SAA of Coronel Fabriciano, Ipatinga and Timóteo in relation to the lost volume of GRIP, with Ipatinga being the most relevant, representing 40% of the total volume lost by GRIP, followed by Coronel Fabriciano with 21% and Timóteo with 16%.

Another activity carried out in the diagnosis phase was the calculation of the Water Balances of UNLE, its five Regional Managements and the SAA of Coronel Fabriciano, Ipatinga and Timóteo, whose results presented confirmed that real losses were the main responsible for the loss rate, reaching the level of 70% of the total lost volume.

At a strategic level, one of the most relevant actions developed in order to achieve effective results in reducing water losses at COPASA was the implementation of the Water Measurement Technology Center.

Developed under the responsibility of the Hydrometry Service Unit – USHM, the Water Measurement Technology Center is premised on the Management of all operational processes inherent to Macro and Micromeasurement, with its Technicians committed to working in line with the strategy defined by the Company and support Operational Management in the entire list of activities linked to the Losses process, such as specification and acquisition of equipment, in order to guarantee the application of available resources in a consistent and responsible manner, training to carry out the target activities and analysis of the results achieved.

After knowing the reality to be faced, actions were defined in accordance with local realities, the most relevant being the calibration of the main macro meters, research for non-visible leaks and the renewal of the

water meter park. Carrying out these actions brought into context the application of low-cost technological innovations that adhere to local realities and needs, including:

1. Calibration of macrometers: use of the pitometric mapping procedure using differential pressure measurement modules.

Particularly pitometric mapping using a differential pressure measurement module is of high interest in the development of this work since it is a technology developed by COPASA Technicians in conjunction with a company that develops macro-measurement equipment, presenting itself as a suitable solution for need and cost-benefit appropriate to the operational reality, and can be used in the laboratory or in the field, as shown in Figure 3.

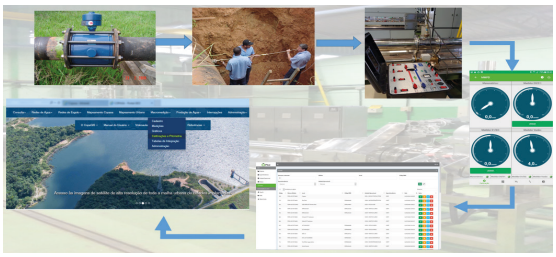

Figure 3 – Technologies Calibration of macrometers

This system has a supervisory system which, through algorithms, provides data acquisition control for the positioning of the Pitot tube, when inserted into the pipes to determine the velocities at the section points and consequently the flow survey. Thus, Copasa holds online the results and controls of the calibrations of its respective macro meters.

2. Search for non-visible leaks: developed on a large scale, using Procedure PR-051 of Norma abendi as a model. In addition to the conventional methodology, using a listening rod and geophone, innovative technology was also used, an automated system, equipped with mobile sensors, georeferenced data collection and artificial intelligence.

As previously mentioned, the activity of researching non-visible leaks had been carried out within the scope of some UNLE operational teams, having been incorporated into routine activities, not only focusing on reducing water losses, but also in situations of shortages, mainly connections located in higher areas and/or distant from the Production System.

Especially at GRIP, the investigation of non-visible leaks already represented an action to control water losses in the SAA of Ipatinga and Timóteo, since it was the total domain of the operational team, which had been increasingly developing and disseminating the technique among its employees. employees, but still outside of a Distribution Loss Index Management Action Plan.

Combined with the local context, in order to optimize and ensure greater agility in carrying out this activity, the Company acquired an innovative technology, an automated system, equipped with mobile sensors for collecting georeferenced sounds and artificial intelligence capable of analyzing the collected sounds, indicating the places most likely to be caused by the presence of non-visible leaks.

Figure 4 shows the georeferenced collection of sounds, which, after analyzed by artificial intelligence, will indicate whether or not it is the location of a possible leak, and accessories used to search for leaks not visible in the automated system.

Figure 4 – Search for non-visible leaks – Automated system

1. Renovation of the water meter park: management carried out using a digital tool (Business Intelligence - BI), developed within the Water Measurement Technology Center, specifically for this activity, by Company employees, proved to be one of the pillars with the greatest impact in reducing losses. Figure 5 illustrates the workspace of Developer Technicians. This includes the training of employees involved as a determining factor in achieving the initially established goals.

Figure 5 – Water Measurement Technology Center_Workstations of Technicians responsible for Micromeasurement and Hydrometry Laboratory

The developed BI allows establishing the Annual Hydrometer Replacement Plan based on the criteria adopted based on the meter's technical characteristics, the customer's consumption history and installation time. In this context, the Annual Hydrometer Replacement Planning now includes the segmentation of water meters to be included, distributed by regionalization (business unit, regional management, location, sector-route and supply zone), characteristics of the meter (age, type, model, metrological class and predicted IDM) and consumer characteristics (monthly consumption, category and branch of activity), when monthly application schedules are drawn up, thus becoming a Micromeasurement Management tool.

Another relevant factor for the success of the Loss Reduction Action Plan at UNLE was the application of resources to replace assets, when a recurrence of network disruptions is diagnosed, and the acquisition of equipment and new technologies, to guarantee adequate conditions for the development of activities necessary to fulfill the Action Plan and achieve the established goals. It is also important to highlight that for the adequate training of the team involved in the Loss Reduction Action Plan, the Company made available to them the course Formulation and Execution of a Strategy to Combat Losses in Water Supply Systems, which addresses the methodology indicated by IWA. The knowledge acquired during the training was applied both to the initial diagnosis and to monitoring the results throughout the work.

Figure 6 shows the use of the Water Balance components being used to define actions in line with the local reality.

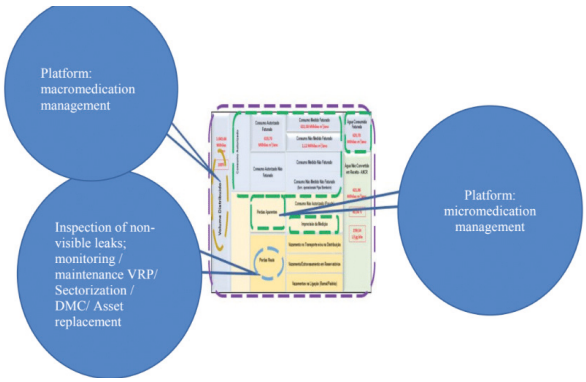

Figure 6 – Application of the Water Balance calculation in the Governance of the Water Loss Process

The calculation of the Economic Level of Losses – NEP was also exercised, a subject of high relevance in the learning acquired through the training provided to Technicians involved with the development of the East Business Unit's Loss Reduction Action Plan.

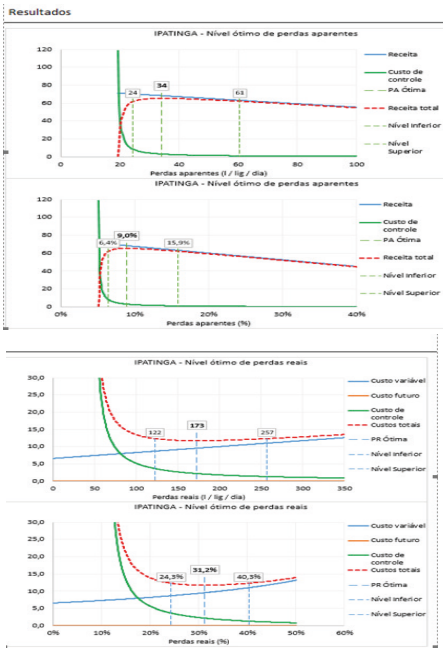

Figure 7 – Application of the NEP calculation in the Governance of the Water Loss Process

RESULTS OBTAINED

For the Loss Reduction Action Plan, the annualized indicator was adopted, that is, to calculate the indicator, each month uses the sum of volumes from the last 12 months and the number of days accumulated in the period, with the unit being liters per connection per day (L/lig/day).

In January 2020, the distribution loss rate at UNLE was 195.04 L/lig/day reaching 173.48 L/lig/day in September 2022, the final period described in this work.

The target established for the Distribution Loss indicator, to be achieved by December/2023, for UNLE is 171.94 L/lig/day.

Figures 8 to 10 show the evolution of the result of the Distribution Loss indicator in liters/connection/day, for the period from January/2020 to September/2022.

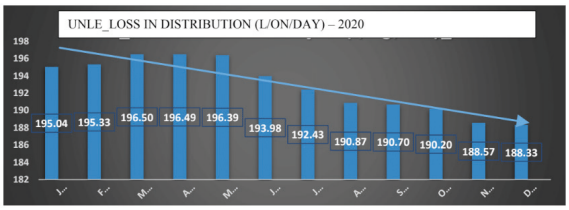

Figure 8: Loss in distribution indicator result/2020

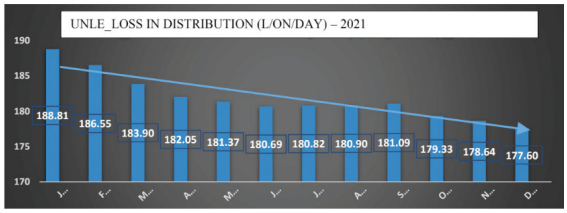

Figure 9: Loss in distribution indicator result / 2021

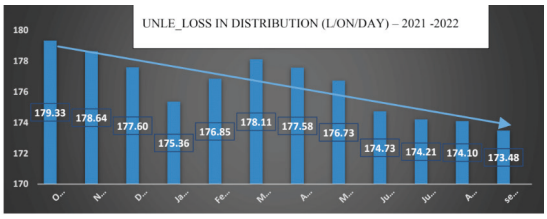

Figure 10: Distribution loss indicator result -2021/2022

RESULT ANALYSIS

The decrease of 21.56 L/lig/day, in the Distribution Loss indicator, in the period from January/2020 to September/2022, confirmed the effectiveness of the Loss Reduction Action Plan developed by COPASA in the region located in the East of the State of Minas Gerais, including in January 2020, 641,482 water connections operated with a supplied population of 1,571,316 people, in a coverage area of 6,098,863 meters of distribution network, with production of 119,225,647 m^3/year and volume consumed in the range of 74,495,131 m^3/year, with a loss of 195.04 L/lig/day recorded, when the Water Loss Reduction Action Plan began.

Figure 11 shows a decrease of 1.10 percentage points in the impact of the Annual Lost Volume_UNLE in relation to the Annual

Lost Volume_COPASA and, subsequently, Figure 12 shows a decrease of 1.84 percentage points in the impact of the Annual Lost Volume_GRIP in relation to the Annual Lost Volume_UNLE, for the period from January/2020 to September/2022, ratifying the significant result in reducing losses in the East Business Unit, based on the development of actions listed as priorities in the Loss Reduction Action Plan developed in that region.

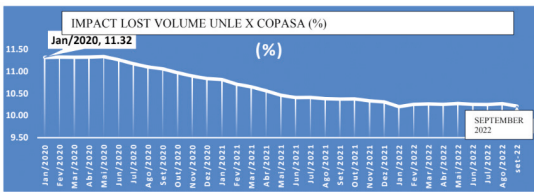

Figure 11: Decrease in the impact of Annual Lost Volume_UNLE in relation to Annual Lost Volume_COPASA

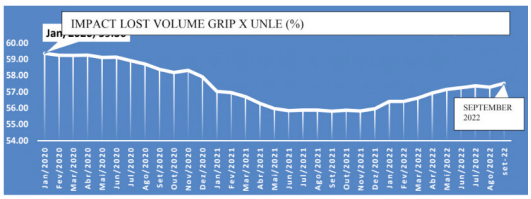

Figure 12: Decrease in the impact of Annual Lost Volume_GRIP in relation to Annual Lost Volume - UNLE

CONCLUSIONS/ RECOMMENDATIONS

It is concluded that it is essential to continue carrying out and managing the calibration actions of the main macro meters, researching non-visible leaks and renewing the water meter park, in this Action Plan defined as main activities, acting in a personalized way in each Supply System, according to the components of the Water Balance.

The research and application of new technologies, and the adequate training of the team involved, are factors that have proven to be essential in the development of activities focused on reducing water losses in distribution. The first step is to identify real needs, based on a careful analysis of the local situation, which allows for the fair application of resources and the achievement of the purpose.

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