WATER LOSS DETECTIVES

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SUMAR

TOWARDS SUSTAINABLE NRW REDUCTION: AN INNOVATIVE APPROACH

Approaches towards NRW reduction most often tend not to look at the organization as a whole, but rather narrowly at the components of NRW in isolation. Frequently neglected in the design of the interventions, are the following key issues:

I. the dynamic nature of NRW and the interactions of its components;

II. the operator's capacity to cope with the intervention;

III. the change process that needs to take place in the organization to internalize the intervention and secure the gains in performance in the long term.

Based on these pillars, reduction of NRW requires a structured holistic approach built on a long-term strategic plan which entails the following three phases:

- "REDUCE": A first phase which comprises major interventions geared toward significant NRW reductions,
- "FINE TUNE": A second phase cantered in fine tuning the operational performance of the utility towards reaching the economic NRW level, and,
- "SUSTAIN": The third and final phase to maintain the utility's performance at the economic level of NRW with minor, but annual recurrent investments with full cost recovery.

The dynamics of water losses, physical and commercial

Network efficiency at any moment is the combined result of its natural deterioration and the measures that have been put in place to fight this deterioration. If nothing is done, there will be an accelerated proliferation of leaks and occurrences of defective water meters, as well as the accumulation of out-of-date information in the customer and network databases. To counter this natural deterioration tendency it is necessary to understand its causes and to carry out appropriate actions to minimize their negative effect. Many practitioners make the common mistake of having the false impression that each time a leak is repaired, the physical loss is reduced by the volume saved, and that, each time an illegal connection is regularized; the commercial loss will decrease by the associated consumption. The dynamics however are more complex. The boundary between physical and commercial losses can move and physical losses may migrate into commercial losses or conversely. In other words some loss migration may appear as collateral effects of the main actions to reduce NRW.

The Economic NRW Level

Any improvement of the commercial losses does not affect the ELL. The economic level of managing a network (hence the concept of Economic Level of NRW) may be different from the ELL. The challenge is to determine that NRW reduction strategy that yields a certain level of reduction at the least cost. This implies finding the optimal mix of decision variables within given boundary conditions, including repair vs. replace, prioritization in time and space, selection of pipe material, pressure management. This requires to piece solutions together by comparing alternatives and analysing trade-offs. There is a level of leakage below which it is not cost effective to make further investments, or to use additional resources to drive leakage down further. The ELL may however alter in periods of water shortage (drought) vis-à-vis periods of water abundance. Hence management planning will change and move from reduction of leakage, highest in terms of volume saving potential (in time of scarcity), towards reduction of leakage, highest in terms of potential financial benefit from the zones with a higher unit cost of water.

Moving away from short-term interventions

Starting from the concern of how making gains of NRW efficiency sustainable, recent experiences show a tendency to move away from short-term interventions (or "business as usual"). The emerging typical duration of a NRW targeted intervention is at least 10 years, with three distinct phases:

I. Substantially reducing NRW, breaking the vicious cycle, with major investments in leakage reduction as appropriate.

II. Fine-tuning towards achieving the economic NRW level, with targeted investments.

III. Maintaining the economic NRW level, with annual minor investments (network renewal rate).

Possible PPP recommended options include:

- A performance based delegated management arrangement with emphasis on both performance and capacity building, combining public finance and attracting private efficiency.
- A ROT (Rehabilitate Operate Transfer) arrangement attracting private sector finance, in combination with a performance based Technical Assistance (TA) thru a WOP -type arrangement, which will also oversee the rehabilitation component.

The critical and key role of NRW in asset management

One of the root causes of high physical NRW levels is failing asset management of the distribution network. NRW captures key elements of operational/financial efficiency and sustainability (service continuity, water quality, demand management, capacity augmentation and financial flows). In order to reach sustainable low NRW levels, short-term interventions need to be integrated within a vision, a strategy, and an action plan for a phased implementation of long-term asset management. Major attention should be given to integrating NRW reduction and control measures as routine activities within the organization of the utilities and embedding them in an overall asset management strategy. The innovative NRW strategy needs to include the following elements:

- An estimate of realistic NRW performance targets over time (i.e. the so-called 'inverse approach'), a time-bound NRW curve from base-line value to target value; (taking into account an eventual transition from intermittent supply to pressurized continuous supply);
- An assessment of (i) the annual network rehabilitation investment needs to make this possible, including a sensitivity analysis; and, (ii) the network renewal rate needed to maintain the targeted NRW performance (to sustain the gains in performance).

Designing a NRW Strategy

The primary stage in designing a NRW strategy is to quantify water uses and losses and understand the network operation and performance. There is in general no one standard approach and the strategy must be tailored to each individual water utility. The strategy advocated in this report comprises the following elements:

- Specific, to take account of all relevant factors;
- Holistic to address all components of NRW, Commercial, Physical and Unbilled Authorized Consumption;
- Baseline and Target Setting;
- Auditing and validation procedures, both internal and external, to achieve sustainability of results achieved.

Practice has proven that a passive control policy is insufficient to moderate Non-Revenue Water. Crisis management can result in damage to roads and housing, loss of supplies, difficulty in manpower planning, premium costs for repair and the loss of large volumes of water. It is true to say that within any distribution system there is a "Natural Rate of Rise" in NRW. This is primarily caused by on-going deterioration of the water meters and of the network, new leaks and bursts, and in doing "business as usual". Therefore, a passive approach will result in a continuous rise of the NRW, as shown diagrammatically in Figure 4, with detrimental effect on the level of service to the consumers. Gradually this deterioration may result in intermittent supply and ultimately to a complete failure by the water utility to continue to provide the required service.

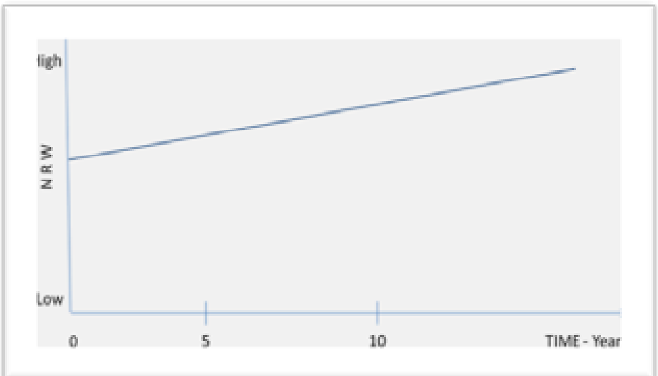

Figure 4 Passive approach to NRW

The Commercial and Physical Losses will have a continuous tendency to increase with time (Figure 4) unless they are constrained by a combination of the four management activities described above. It is thus the responsibility of the water utility to identify the most appropriate combination of these activities for each system according to its circumstances, characteristics and modalities.

To turn around this situation and to stop the vicious circle of continuous deterioration of NRW levels it is imperative that a structured approach is established and that the required interventions are put in place in order to have the desired results for water utilities. The rationale outlined in previous sections is conceptualized and transformed into tangible and practical actions through structured interventions within the framework of a Non-Revenue Water long term strategic management plan as illustrated in Figure 5.

Reduction of NRW requires a structured approach based on a long term strategic plan which will entail the following phases:

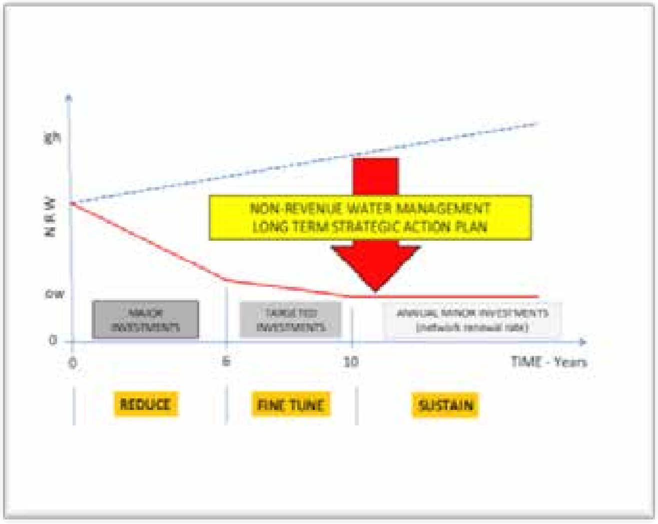

Figure 5: Structured Interventions in a long-term NRW strategy

1. The first phase will comprise major interventions, which will be geared towards reducing NRW from high to lower more manageable levels. This of course will require the corresponding investments in order to achieve the necessary results. A typical time period for achieving satisfactory results is 5-6 years.

2. The second phase could be of shorter duration than the first phase, 4 – 5 years, and is cantered in fine tuning the operational performance of the water utility by applying targeted investments in areas that will have the maximum impact in reducing NRW to an economic level.

The third and final phase is equally important as the first two. Having reduced the NRW to an economic level it is imperative that a framework is in place that will maintain this performance thus achieving sustainability of operations with only minor but annual recurrent investments.

Each of the above phases will have an immediate, medium or long-term strategy attached to it dependent upon their duration and whether they are one-off or on-going expenditures. The following time scales may be applied:

- Short Term or Immediate Measures – normally implemented in six months to one year
- Medium Term Measures – have time scales of one to five years
- Long Term Measures – have time scales of more than five years

For example, production metering will take less than one year to implement and is necessary for the assessment of the Annual Water Balance that will determine future investment strategies. Production metering is therefore seen as a "short term" or "immediate term" measure.

It must also be recognized that individual options from the range of options to be applied may not necessarily be implemented in isolation. Additionally, the sequencing of options may be restricted by practical considerations. For instance, it is not possible to introduce effective pressure management into a distribution network where network zoning has not been implemented. These practical considerations impose a certain logical sequence to the implementation of the investment options. Whilst it is always desirable that the "least cost" options are carried out first, this cannot always be the case when the logical sequence imposed by practical considerations must be followed.

Defining the Problem before Implementing Reform Process

It is important to establish the issues/problems with the existing arrangements with regard to operational efficiency, deficient investment, fiscal impact / government exposure. The main improvement goals need to be specified as well as the strengths and weaknesses established the legal & regulatory environment and the political constraints.

Successful Change and Sustainable NRW Reduction

Successful change requires in addition to a structured innovative strategy a strong element of personal leadership. The challenge is how to 'de-personalize' good utility performance and how to anchor the good results of change and reform, and to make them robust and sustainable.

Bambos CHARALAMBOUS
Jan JANSSENS

Bambos Charalambous is Managing Director at J2C Water Ltd, Lemesos, Cyprus, bcharalambous@cytanet.com.cy.

Jan Janssens is Principal Director at J2C Water Ltd, Geneva, Switzerland, jangjanssens2009@gmail.com

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JD7 LTD - INVESTIGATING THE WEST COAST

As part of a pilot project with the City of Vancouver, Canada, a quadrant delimited by Prince Edward Street, between 34th and 36th Street, was selected in order to perform an internal pressurised inspection using the JD7 Investigator™ unit.

The JD7 Investigator™ watermain condition assessment tool for in-service distribution systems is a next generation, game changing device for asset management. Pairing a High Definition camera system with hydrophone technology, as well as a high powered sonde, the Investigator™ allows for the inspection of assets ranging from 100 to 300mm all while maintaining the lines in full service. Utilizing various pre-existing entry points such as fire hydrants and pressure fittings, minimal preparation is required for an intervention.

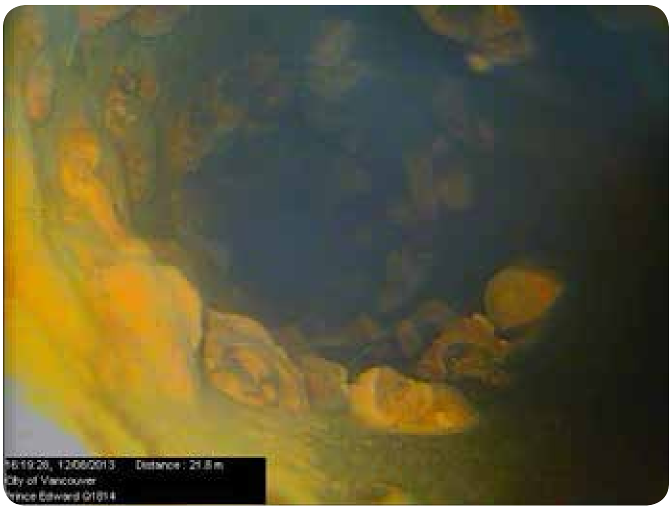
For the purpose of this project, nine (9) access points were selected in the Vancouver area. The launch system utilized with the equipment was adapted in order to provide access into a vast majority of fire hydrant models from the major manufacturing companies including both slide-gate and compression style hydrants. The particularity of the Vancouver region is not only the fact that slide-gate hydrants are still very much present in the network, but also that the vast majority of the hydrants in the region are manufactured by Terminal City Iron Works LTD. and are only readily found in British Colombia.

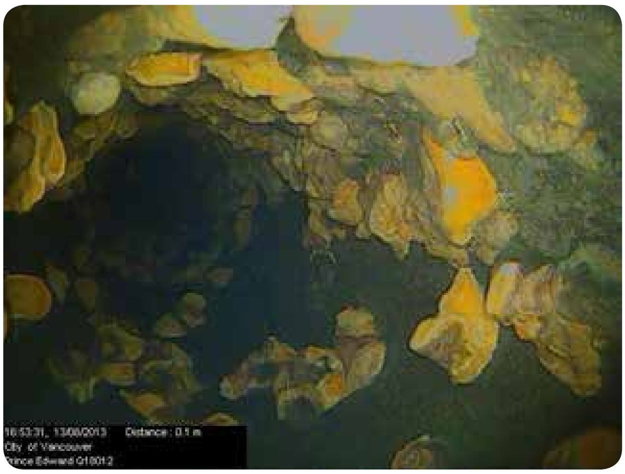
Having never worked with such a model of hydrant before, it did not surprise us when we realized modifications would have to be made to our current launch apparatus to accommodate the variances in design. Since slide-gate hydrants are considered to be antiquated in water distribution systems, it was also surprising to see so many in good working order. It was concluded that, in order for our rig to work properly, we would have to devise a way to simultaneously seal the single drain plug in the shoe as well as isolate the barrel, essentially transforming the barrel into that of a wet-barrel hydrant. A solution was quickly developed and, with the modifications completed on the launching device, only a rapid adjustment was then required between hydrant mobilizations to accommodate for the varying burial depths. Our approach for proper completion of the project began with completing the direct tapping insertion as well as all the slide-gate hydrants and finish with the more conventional compression style hydrants.

Throughout the inspection process of the various watermains, we were able to identify sectors which had been rehabilitated with cement mortar lining as well as others which hadn't been examined yet. The cast iron lines which had been lined showed no signs of tuberculation throughout the pipe other than at the Tees and various bends or valves. The cast iron lines which were approximately of the same period, without having undergone rehabilitation, were now showing signs anywhere between 5 to 20% reduction due to tuberculation. Despite encountering some areas with heavy tuberculation, no acoustic points of reference or anything that may have been perceived as a leak were detected. The nine (9) access points which were utilized allowed us to cover over 300 m of watermain in the area.

Having identified zones where tuberculation was becoming an issue, the City now possessed the documentation validating the actual condition of the watermains in that area. As a result of the work performed, the unlined mains have been identified as rehabilitation candidates in the near future.

David GOSSELIN
Donny WONG

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City of Vancouver


Q18015
Q18014
50 mm diameter brass ball valve direct tap
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Q18012
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Q18003
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Q18011
Investigator™ Access Point
Inspection Path

LEAKAGE, A BROAD MULTI UTILITY PERSPECTIVE

For the majority of my working life I have been involved in soil mechanics and Trenchless technology. Repairing or renovating problems in gas, water and drainage pipes. These works, were and are, predominantly as a result of leakage or structural integrity.

I read the Editorial's and papers in "water loss detective's magazine" with great interest.

But my experience in different utility sectors enables me to take a different perspective.

The loss statistics of clean water supply and the wastage of treated water drive the majority of leak detection projects, however it is not the only factor, leakage and it's effect on the surrounding ground conditions, soil movement, cavitation and bridging on adjacent utilities can have catastrophic consequences.

Result of water main burst

Although the majority of my current work is in the drainage sector, one of my more recent projects has been concerned with detection of leaks, mostly driven by pollution and contamination issues or the stabilisation of cavities produced as a result of leakage or infiltration. Yes this is a different sector but I believe that it is relevant, because it takes a different approach and uses different technology, in non-pressure pipes with poor noise propagation.

Detecting leaks successfully in all pipe materials, different soil conditions and different pressure regimes requires a range of different resources many of which have been developed in different utility sectors for different reasons.

Detection of leakage in all utility pipes is driven by different priorities but the common thread is using available resources to locate and then pinpoint the location of a pipe defect regardless of material, pressure or purpose and a range of technology is available for this.

200mm PVC water main burst.

We have recently invested in a system that measures different electrical flow through pipe defects. A graphical analysis clearly identifies the areas of leakage. A visual display will identify problem areas and a site print out is available.

Since electricity flows through the slightest crack and around corners, we can locate ALL defective pipe joints and sewer tap connections that CCTV can't by visual inspection. In addition to identifying locations. It is also possible to assess the size of a leak. The bigger the electrical flow, the bigger the defect, the bigger the leak. The type of defect – joint, tap, or crack, is shown by the pattern of the electric current.

This system combined with a CCTV unit and a professional acoustic leak monitor aims to provide a range of technology to identify and pinpoint any leak in any material.In order to mobilise a unit with these capabilities it has been necessary to research all areas of current leak technology and evaluate the available systems to provide a tool kit that can operate in a broad area of pipe material and operating pressures.

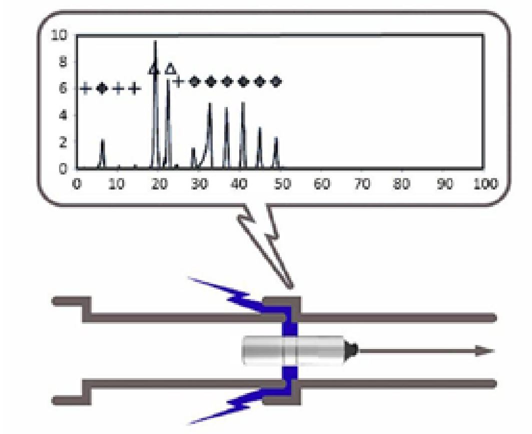
After researching available options we have narrowed our choice of equipment based on a matrix of advantages for each technique. Research and development projects are currently in progress to develop variations of this system for large diameter water distribution and open channels.

Researching in new technology and investing in sophisticated equipment helps but never forget that an experienced operator can save much time and resources.

Never underestimate observation in the first instance. Interpretation of results is a key element of all the available techniques.

Some of the latest developments in leak detection relate to enhancing the operators senses using technology, such as filtering background noise for listening devices and

Fine tuning in certain noise frequencies. When detecting leaks in water mains we are focused on water loss, but the consequences of leaving these defects



undetected can also have dramatic consequences such as sink holes, damage to adjacent utilities, damage to roads, undermining of concrete slabs, subsidence, erosion and pollution.

GPR technology is used for many applications such as locating voids under pavements, voids in concrete and tracing underground utilities from the surface.

By sending radio signals into the ground the return signals provide information about changing ground characteristics with depth. The radar measures depth

In terms of time it takes for a signal to return. GPR technology is very successful at locating anomalies in the subterranean environment, however as with all systems interpretation of the results is a particularly skilled operation.

Whatever the utility or kind of leak the same procedure applies to localise, locate and pinpoint. Saving Water is necessary but finding leaks before they result in dramatic consequences is essential.

Graham G. EVANS
E.R.Technical Services

Romanian Water Leak Challenge, 2014

MIYA AWARDED PRESTIGIOUS IWA WATER SUPPLY AWARD FOR IMPROVING THE EFFICIENCY OF MANILA'S WATER SYSTEM, DELIVERING WATER TO AN ADDITIONAL 2.6 MILLION PEOPLE

Miya, Arison Investments' global leader in urban water efficiency solutions, established by Shari Arison in 2008, has partnered with Maynilad, the private water utility serving western Manila, to deliver clean water to as many city residents as possible, in a sustainable way that is both environmentally beneficial and cost-effective.

Maynilad is the water and wastewater services provider for the western zone of Manila, serving some 9 million people. In 2008, 67% of the water put into their delivery system was lost (non-revenue water; NRW), mostly due to leakage. One third of residents in western Manila lacked a connection to the municipal system and well over a million suffered from intermittent supply or low system pressure.

Understanding that a comprehensive water efficiency program, combined with world renowned expertise, is needed to solve the problem, Miya and Maynilad signed a performance-based partnership contract in 2009 aimed at significantly reducing NRW, improving water service to residents and enhancing the utility's relationship with the community. The project earned the IWA Award for Project Innovation in the drinking water supply category.

Arison Investments Chairman and CEO Efrat Peled says: "Miya was officially inaugurated at the 2008 IWA conference in Vienna, and receiving this prestigious IWA Award in 2013 signifies the industry's recognition of Miya's achievements worldwide, based on its comprehensive approach to efficient management of our world's existing fresh water abundance."

Miya is known for its proven success in water efficiency projects around the world, employing an international team of experts, applying strategies such as leak detection, pressure management, meter management and more. As David Arison, Miya's Vice President of Global Business Relations says: "Miya's projects prove beneficial for both the community and the environment, while drastically improving the financial situation of the water utility. Customer service levels are enhanced, local jobs are created, community awareness to water efficiency rises and energy consumption is reduced."

To date, the project has been a great success: NRW was reduced from 67% to 38%, saving about 800 million liters per day of water, an additional 2.6 million people now receive a consistent flow of fresh water from the municipal system and water is supplied 24/7. The work is on-going, with 450 trained Filipino engineers. Due to fewer leaks and improved services, Maynilad's income has increased to three times that of 2008. The utility is now fiscally stable, thus enabling it to expand its budget and system coverage.

The Miya-Maynilad NRW reduction partnership has led to a significantly better water delivery system in one of the largest urban areas in Southeast Asia. The partnership has raised awareness to the importance of preserving the abundant supply of clean, fresh water, and maintaining an efficient water delivery system without wasting this precious resource to leaks. The Maynilad team has been empowered with a set of skills and the ability to perpetuate the achievements of this ambitious water efficiency project.

This project also serves as a stellar example for the entire region on how an effective NRW reduction program can be so effective that it essentially pays for itself. Just as in Maynilad, water utilities can provide customers with clean water, uninterrupted and all day, without producing more water, a major capital investment. With a forward thinking, innovative project such as the Miya-Maynilad partnership, a smart investment in an environmentally conscious project leads to sustainable change that mutually benefits the utility and the consumers it supplies.

Noa UNI
Director of Global Marketing
Miya Water

About Miya

Miya was established by Shari Arison in 2008 as part of Arison Investments, with the vision of ensuring an abundance of fresh water, through efficient management of our world's existing fresh water resources.

More than a third of the world's drinking water is lost from municipal supply systems, mainly due to undetected underground leaks. The most sustainable and cost-effective way to prevent such losses is to improve the efficiency of urban water distribution systems by effective water loss management.

Miya optimizes water supply in urban water systems worldwide. It partners with utilities to design and implement comprehensive technology-based solutions that significantly improve the client's financial and operational efficiency, while also enhancing customer service levels, reducing energy consumption, and lowering contamination and health risks, to benefit people, community, and the environment.

Miya's solutions comprise an audit of the city's water system, full project planning, on site execution, maintenance and training. Holding vast experience in implementing water efficiency projects around the globe, Miya is primarily active in Brazil, South Africa, Canada, the Caribbean, and the Philippines.

www.miya-water.com

About Arison Investments

Arison Investments is a privately owned global investments company, and the business arm of the Arison Group. Managing a diversified portfolio of international investments valued at over $2.5 billion, it comprises 27,000 employees in 40 countries across 5 continents, delivering solid financial performance through values-based investments.

Arison Investments creates long-term business investments that combine substantial financial results with sustainable moral responsibility. It provides values-driven responses to basic human needs of large populations in the fields of finance, infrastructure, real estate, renewable energy, and water. It is looking at future investments in developing countries, focusing on food, education and infrastructure.

Arison Investments views the impact of any investment as paramount. A clear strategy of moral responsibility is applied in building long-term business partnerships that positively impact both people and planet. All investments are oriented at enhancing the quality of life and preserving the natural environment, while delivering solid financial returns.

http://www.shariarison.com/en/content/arison-investments-0

7TH INTERNATIONAL CONFERENCE WATER LOSS REDUCTION IN WATER SUPPLY SYSTEMS

First Announcement & Call for Abstracts

10 -11 November 2014

Inter Expo Centre, bul. Tzarigradsko Shosse 147, Sofia, Bulgaria

Water loss in water supply systems is a serious problem for almost all urban areas around the world and it can be even worse in areas with scarcity of water. This problem deserves immediate attention and appropriate action to reduce avoidable stress on scarce and valuable water resources. Several big cities have already started programmes geared towards the step-by-step reduction of the losses and it is well known that many institutions and water and sanitation utilities have developed and implemented strategies and technologies to control leakage and water loss. These strategies have proven highly efficient and received worldwide recognition.

The conference will be held for seventh consecutive year and is considered to be the major annual water loss event in the Balkan region. This year's conference will document available know-how and best practices and will recommend new approaches for more efficient management in the field of water with a focus on water loss reduction.

The conference is supported by the European Water Resources Association (EWRA). EWRA is a leading European non-profit organisation aiming at the enhancement of cooperation and the exchanges in application and research on all aspects of water resources. EWRA's activities include organisation of conferences, symposia and training courses, publication of journals, bulletins, conference proceedings and newsletters, as well as expert knowledge networks. Further information regarding EWRA can be found at www.ewra.net.

The conference will be held on Monday, November 10th and Tuesday, November 11th (morning). It is aimed at decision-makers and experts in the water supply field as well as for companies - producers or distributors of the respective equipment.

LEAKS ON LARGE-DIAMETER TRUNK MAINS – MORE THAN JUST NON-REVENUE WATER REDUCTION

Providing safe, reliable access to clean water is a major challenge for utilities around the world considering that roughly 12 billion gallons of water are lost every day globally. While many utilities are aware of the importance of reducing Non-Revenue Water (NRW), reducing it can be a challenge. The World Bank estimates that NRW costs utilities worldwide about US$14 billion every year. By reducing these losses by half in areas with the highest NRW, it is estimated that US$2.9 billion cash would be generated and an additional 90 million people could have access to water.

Although there are many factors that contribute to NRW, one of the most significant causes is leakage on aging water pipelines. Much of the water and wastewater infrastructure around the world is aging and reaching the end of its design life – this is leading to a greater number of leaks and pipe ruptures. While these occur most frequently on small-diameter distributions mains, leaks and ruptures on large-diameter trunk mains are a much larger concern for utility operators.

Leaks on trunk mains often account for a much higher percentage of the total water lost from leakage than leaks in the distribution system. This is primarily

because trunk mains carry water at a much higher capacity and operating pressure than distribution pipelines, but also because the lower frequency of trunk main leaks leads to many of these problems not being identified for long periods of time.

A study completed by the *American Water Works Association* in Birmingham, Alabama in the USA found that while only 5 percent of the total leaks were found on trunk mains, these leaks accounted for nearly 50 percent of the water lost. By focusing leak detection programs on large pipes, a utility can achieve a large reduction in NRW by identifying and repairing even one trunk main leak. In other words, leak detection on large pipelines can yield a high Return on Investment (ROI) for water utilities.

In addition to focusing leak detection efforts on large-diameter trunk mains, it is important for utilities to be able to identify small leaks on these pipelines. In terms of reducing NRW, finding and repairing small leaks may actually represent the best opportunity for long-term water loss reduction.

Leaks on large-diameter metallic pipelines typically form and mature over a period of years or decades. They tend to grow larger over time, up until a point where the pipe fails and the leaks surface. Locating and repairing a large leak prevents it from leaking for the “tail end” of its life, and from failing catastrophically.

Catching a leak while it is very small does this as well, but also prevents the years of sustained water loss that would occur as it grows into a large leak. Using technologies that can locate small ‘pinhole’ sized leaks can identify small leaks early on before they grow into larger leaks or lead to pipeline failure.

How utilities can detect trunk main leaks

There are several methods of locating leaks on water pipelines. Non-invasive methods, such as correlators or listening sticks, work very well on small-diameter distribution mains but often lack the accuracy needed to address trunk mains as the sound of a leak does not travel as well as pipe diameter increases.

Conversely, inline leak detection methods aren’t well suited for distribution mains due to pipe size and complexity, but are very effective in accurately locating leaks on trunk mains because they bring the leak detection sensor directly to the source of the leak, unlike non-invasive systems.

One of the major challenges utility operators deal with is accurate location of leaks on critical trunk mains. These pipelines – which are often a crucial supply of water for a large number of customers – sometimes run beneath busy streets, meaning operators cannot afford to shut down service and excavate large portions

of a city street to search for suspected leaks, making precise location very crucial. Furthermore, trunk mains are usually long and lack regular access points, making traditional approaches ineffective.

Inline leak detection tools can locate leaks with close location accuracy, usually within 1.8-meters (6-feet) or closer, because the leak detection sensor passes the leak location directly, therefore providing a very accurate location estimate. Tethered systems that are controlled by a ground level operator are the most accurate in locating leaks, since the technology operator can control the leak sensor and verify leaks in real-time.

By using inline leak detection methods that precisely locate leaks while the line is under normal flow conditions, operators can effectively reduce shutdown and excavation times, allowing for fiscally responsible and efficient repair projects that don't disrupt busy metropolitan areas.

Another benefit of inline leak detection methods is their accuracy in estimating the size of a leak. The results from an inline leak detection survey provide a precise water loss estimate for each suspected leak. This allows operators to decide whether to excavate a leak immediately or defer the repair of a small leak in the interim. This helps operators with large-diameter pipelines in busy metropolitan areas because repair projects can be costly, disruptive, and sometimes unnecessary if the cost of the project outweighs the

benefit of repairing the leak. With the location and size of the leak known, operators can create repair schedules and prioritize rehabilitation projects to avoid unnecessary service disruptions.

Leak detection as an indicator of pipe condition

Having a well-developed leak detection program for large-diameter trunk mains is an important aspect of reducing water loss; however the benefits of leak detection go beyond just NRW reduction. Leak detection is often used as a precursor for a complete structural assessment using other technologies.

In Concrete Pressure Pipe (CPP), leak detection provides operators with information on joint condition, as leaks on CPP frequently form at the joints. Combining this with an electromagnetic (EM) inspection will provide a comprehensive look at the overall condition of the pipeline in terms of structural integrity, leakage and joint condition.

In metallic pipe materials, leak detection is an

important prescreening tool in identifying potential failure locations. When a metallic pipe fails, there is usually a period of leakage at the failure location prior to the rupture. While failure locations will not always leak prior to rupture, it is prudent for operators to limit the risk of failure through the use of regular inline leak detection, which is a cost-effective method of determining the condition of metallic pipes. With advancements to inline inspection methods for metallic pipes, leak detection can now be paired with these methods to determine the baseline condition of most metallic pipes.

Locating small leaks also has a role in determining pipeline condition. A common failure mechanism for trunk mains is known as a "bell split." This involves a crack forming at the bell end of a pipe joint, which gradually grows over time. Eventually, it can become long enough to weaken the pipe wall to the point of failure, allowing a portion of the pipe bell to break off, or the pipe to split open longitudinally. Locating these cracks early when they are leaking small amounts of water, allows utilities to prevent bell-split failures.

Another benefit of inline leak detection tools is their ability to identify air or gas pockets. In water trunk mains, air pockets can adversely impact flow and capacity if they are not released. However, it sewer force mains, identification of gas pockets is very important in maintaining pipe integrity, since the presence of leaks or gas pockets is often a preliminary indicator of a potential failure location.

While the focus of leak detection is primarily on reducing NRW, the process is important in overall pipeline integrity, particularly when paired with structural inspection and long-term management.

Utilities using inline leak detection

In Dallas, Texas, large-diameter trunk mains are at high risk of developing leaks in the summer months. Due to the heat and dryness, the ground becomes extremely hard, this shifts the buried pipes slightly which can cause leaks to develop and increases the risk of pipe failure.

In 2004, Dallas Water Utilities (DWU), which services 2.4 million customers in Dallas and nearby communities, began an ongoing proactive annual leak detection program using Sahara® inline leak detection technology. The program has been extremely effective for DWU, locating 120 leaks in 160 kilometers of trunk main inspection. The estimated water savings from all of the leaks identified and repaired by DWU is about 27.3 million liters per day. DWU has also seen a 17

percent reduction in catastrophic water main failures since the start of the program.

The Sahara platform is a tethered leak detection tool used to locate leaks and gas pockets in pressurized pipelines. The tool allows the operator close control and sensitivity during inspections with no disruption to regular pipeline service. The acoustic sensor is highly sensitive and is able to locate 'pinhole' sized leaks, while also collecting high-resolution video of the pipeline.

In Gothenburg, Sweden, the Department of Sustainable Waste and Water completed a successful leak detection survey using SmartBall® technology on almost 5 kilometers of metallic pipe that ranged in size from 600-mm to 800-mm in April 2013.

From a single insertion point, the inspection identified 17 anomalies resembling leaks, with four classified as large leaks. While the utility staff suspected that the pipeline had a few leaks, they were surprised at the amount detected by the inspection. Work is currently underway to verify and repair the leaks found during the inspection.

The SmartBall inspection tool is a non-destructive, free-swimming technology that measures the acoustic activity associated with leaks and gas pockets in pressurized pipelines. When acoustic anomalies are present, the data is analyzed to determine if it is a leak, gas pocket, or just an external sound. It is ideal for transmission mains as many kilometers can be inspected without the need for regular access.

In both cases, the use of inline leak detection allowed the utility to reduce water loss and get condition assessment data on their large-diameter trunk mains. In Dallas, the program has been extremely successful in preventing pipe ruptures since its inception, while in Sweden, the utility was able to identify several leaks on its large-diameter metallic pipelines, which could have prevented a pipe rupture.

While no single technology can enable utilities to manage underground infrastructure, leak detection on large-diameter pipelines should be an important component of any condition assessment toolbox.

PURE TECHNOLOGIES

UNITED UTILITIES TEAM WINS THE SECOND LEAKAGE GAME LEAGUE

The Leakage Game has been developed by two IWA fellows and active members of the IWA Water Loss Specialist Group, David Pearson and Stuart Trow. In this article they outline how the game is being used to transfer their knowledge in an innovative way.

A team from United Utilities (UK), imaginatively named "Wikileak", were declared winners of the second league of the Leakage Game recently. The league comprised teams from three water supply companies and two consultancy firms from the UK, with a sixth team "The Water Team" basing their decisions on those of the other five.

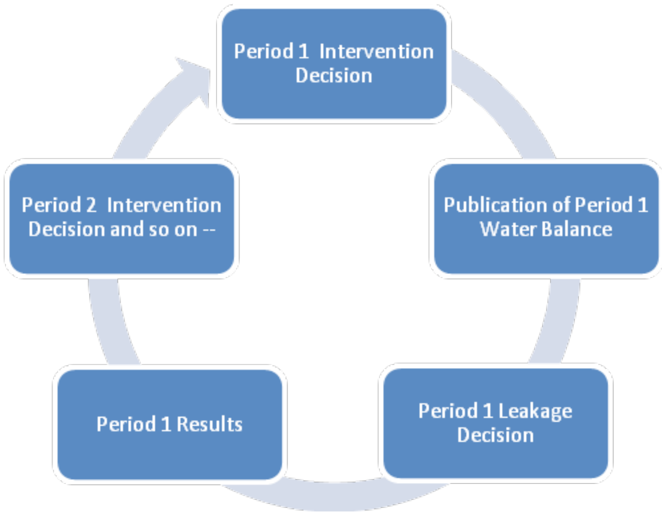
The Leakage Game is a web based learning tool managed through a new organisation, The Water Leakage Association, which will provide governance and regulation of the game across the various leagues. David Pearson and Stuart Trow have worked together on a number of leakage management initiatives and the game is one of a number of ways they have of sharing

their experience with others. It is designed to transfer knowledge of leakage management to participants who play an interactive on-line game.

The management simulation game provides the opportunity for companies to enter teams in a league to pit their wits against each other, and to learn in the process, by operating and managing a "fictitious" water company supplying the island of Avalon, which has three resource zones all with different characteristics. An information pack provides full details of the company and the challenges it faces.

Aimed primarily at managers, engineers, and consultants working in the field of water loss control, the game is also of benefit to non-specialists wanting to gain an overview of the subject. The game can be played by individuals, but is better suited to small teams of between 2 and 4 people with a variety of skills and experience.

The objective of the game is to maximise an overall performance assessment (OPA) score



through a series of intervention decision steps. Each step represents the impact of the investment decision over a period of one year. Each period also includes a decision on the level of leakage that team reports to the regulator.

Each team starts the game with the company in exactly the same "condition". At each step in the process, a decision has to be made as to how much money to spend on each of a set number of activities aimed at controlling leakage and revenue loss. It is not necessary to spend money in every category. Interventions include mains and service pipe replacement, active leakage detection, pressure management, revenue meter replacement and investigation of illegal connections and fraud. These activities have to be balanced against supply side options such as developing new water resources and treatment plants, or building desalination works, in order to avoid restrictions in water use. A sophisticated mathematical model is used estimate the impact of the investment on the water balance and the financial accounts of the company.

KPI	Weight
Total SIM Score	1.00
Water Supply Interruptions	1.00
Greenhouse Gas Emissions	1.00
Infrastructure Serviceability	1.00
Leakage	0.50
Security of Supply Index	1.00
Return on Capital Employed	0.75
Credit Rating	0.25
Gearing	0.50
Interest Cover	1.00

The game is played against other teams and the OPA score depends on how one team is performing in comparison to the other teams in the same "league". This allows players to see how their decisions are impacting on operational and financial performance compared to other team's decisions, and all of this adds an element of competition to the game. The OPA is generated from a number of Key Performance Indicators (KPIs) comprising technical measures including, but not limited to, the reported level of water loss, financial measures, and customer service measures. It simulates the financial accounts for the operating company including loans and depreciation, which make it relevant to general managers responsible for water supply.

Each Key Performance Indicator (KPI) is weighted in the overall OPA score (see table), with the reported leakage value being given a relatively low weight, for reasons which became apparent to the players as the league progresses.

The first league was run during September and October 2013 when a team from Severn Trent Water won the League. The second league was run during May and June 2014 with a week allowed for each decision to give teams time to organise meetings without disrupting normal work. In the second league six decision steps were taken by each team prior to a get together in June 2014 during which the organisers gave training presentations on aspects of water loss and financial management. A further decision step was taken during the day before the results were announced at the dinner in the evening.

The game organisers can introduce external factors and other issues as the league progresses. These can include such things as reductions in abstraction licences due to environmental concerns, sever winters or droughts. During the first league, the Regulator for Avalon announced that he was carrying out a horizontal audit of the water balance in response to concerns over some of the allowances being claimed, in comparison to standard default values and consumption estimates commonly used across the industry. The Regulator has the option to impose a financial or performance penalty against a team if its claims cannot be substantiated.

Team members learn by gaining a better understanding of the impact of their decisions, without it impacting on their real life performance. They also gain from asking questions of the organisers and they have access via the web site to a bibliography of key reference documents concerned with water and revenue loss management, financial accounts and key performance indicators. Observations from attendees at the event were: 'the leakage game is an innovative way to learn about leakage management and have fun', 'a fun game with a serious outcome', and 'good insight into the checks and balances of the numerous variables involved in leakage'.

The Leakage Game was also used as part of a postgraduate programme in the UK during July 2014. In this case a different format was used. Here the game was played as part of an offsite training week with a decision step being taken each day during the week and the winner announced at the final dinner. This format engenders greater competition between the teams as well as giving Stuart and Dave the opportunity to provide more one to one training support. Eight teams took part with participants made up of graduates from UK and American universities.

Plans to launch an international version were discussed at a meeting held during the IWA Water Loss 2014 conference in Vienna in April. The international version will use the IWA water balance methodology, rather than the one used for regulation in the UK, and it will include for the management of apparent losses as well as real losses. Further details of the game can be found by accessing the web site: www.TheLeakageGame.co.uk.

Stuart TROW
David PEARSON

Stuart Trow is Director of Trow Consulting Limited, The Vineries, Chester-le-Street, Durham, DH3 3ND, UK Email: StuartTrow@hotmail.co.uk

David Pearson is Director of David Pearson Consultancy Limited, Yew Tree Farm, Acton Bridge, Northwich, Cheshire, CW8 3QY,UK Email: David.dpc@btinternet.com

STATE OF THE STATES – EMERGING WATER LOSS REGULATIONS IN THE UNITED STATES

Water system regulations in the U.S. have been around for 100 years. 40 years ago, Congress passed the State Drinking Water Act which brought sweeping changes for America's drinking water systems. For nearly all of that time, those regulations have been solely focused on water *quality*. Only in recent years has the issue of water *quantity* found its place in the regulatory arena. Historically, conservation has been a more common practice in the Western U.S., where arid climates and severely restricted supply set the stage. Recent water loss legislation in the Eastern U.S. has begun to bring conservation and supply-side efficiency to the center stage, particularly in the Southeast.

Drivers Can Be Different

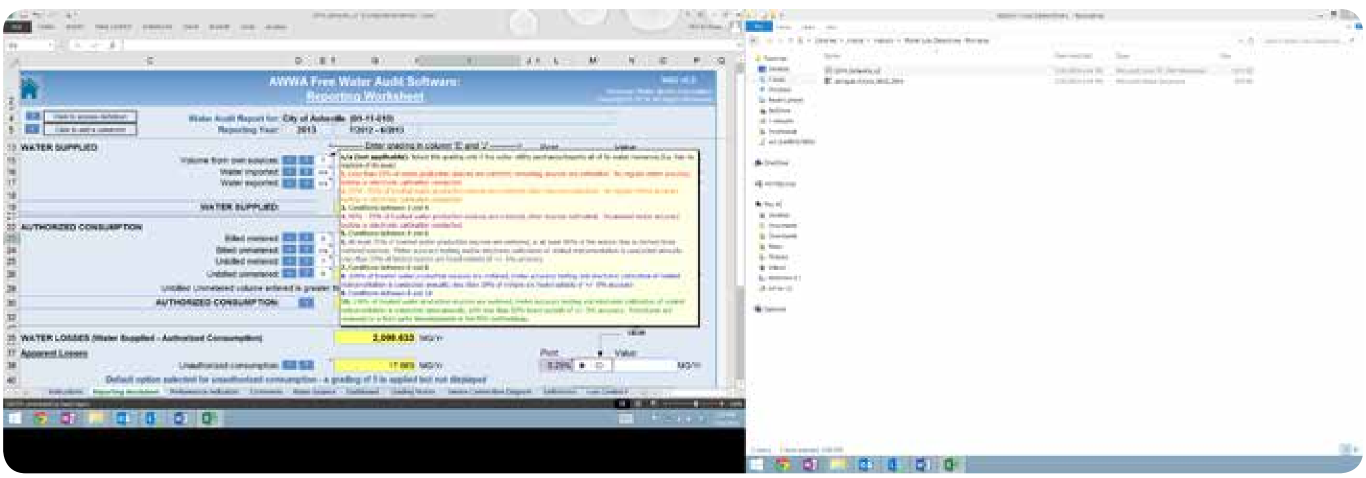
So why do we care about water loss? Just in the U.S., the drivers that make water loss important can vary widely from state to state, even utility to utility. For some, there are extreme drought conditions or arid environments with constrained water supplies that make water loss management a necessary source of new supply and resource stewardship. For some, it's a plain bottom line. There are strained budgets, with expenses outpacing revenues and they see water loss management as fiscal shoring. They understand the inherent business case for system efficiency, including the complex but proven dependency between water and energy. For some, the driver is political – where pending rate increases fuel customer distrust and outrage…"…you're asking me to pay more for your inefficiencies?…", where water loss management provides defensibility and action, and an offset to the severity of the required rate increases. For others, as is the case in Georgia and Tennessee, a primary driver is regulatory. While there tends to be a primary driver, in most utilities, all of these drivers exist to some degree. For this reason, the cost of doing nothing far exceeds the cost of water loss management in both the short and long term.

The IWA/AWWA Water Balance provides a consistent and rational method for calculating and categorizing losses. AWWA, through development of its M36 Manual of Practice and Free Water Audit Software, has further developed a mechanism for quantifying confidence and reliability in the water audit performance indicators, based on the utility's measurement and verification policies and practices. This mechanism is the Water Audit Data Validity Score, and is derived as an assessment on each input, based on detailed grading criteria.

Data Validity must be the first consideration, in using the water audit to guide water loss management activities. Systems with low Data Validity scores must focus next steps on improving data. Those with high Data Validity should focus next steps on reductions in water loss. Those with medium Data Validity scores must examine closely to determine the appropriate balance of next steps for data improvement and water loss reduction.

State of the States

AWWA has long since denounced use of the imprecise term "unaccounted for water" (UFW), as well as percentage based metrics, as they have been deemed inconsistent and unreliable as performance measures. An analysis in 2005 on Water Loss policy and regulation further describes a highly fragmented and complex water supply and regulatory structure. The complexities stem from the sheer volume of regulated community water systems in this country (over 54,000),



Example Data Grading in the AWWA Free Water Audit Software

2011 States Scorecard for Water Efficiency Policy

as well as the intricate framework of regulatory agencies – often multiple agencies in a given state with varying regulatory jurisdiction, and sometimes agencies that regulate water systems across multiple state borders. Further research[6] was conducted by the Alliance for Water Efficiency in 2011-12 revealing that through the network of regulatory agencies, an indication of regulatory momentum is beginning to emerge in the Water Loss arena.

Clearly there have been significant evolutions in Water Loss policy and regulation in just the last 10 years. Figure 4 presents the landscape of states where at least

States with Water Loss Regulatory or Policy Framework

some type of framework exists for Water Loss auditing, reporting and performance targets. The format of this framework varies widely from state to state. In some cases Water Loss auditing, reporting and/or performance targets are *required* by mandate, with varying degrees of penalty for enforcement. In other cases, Water Loss auditing reporting and/or performance targets are not required, but are otherwise incentivized through priority on state funding applications, consideration for new withdrawal permits, or other means.

The following figure presents those states where that regulatory framework exists, and it directly aligns with the best practices of the M36 Method for water auditing and loss control.

A trend that has been reported by most of the M36 early adopter states is an inherent challenge in the reliability of many of the audits submitted, citing

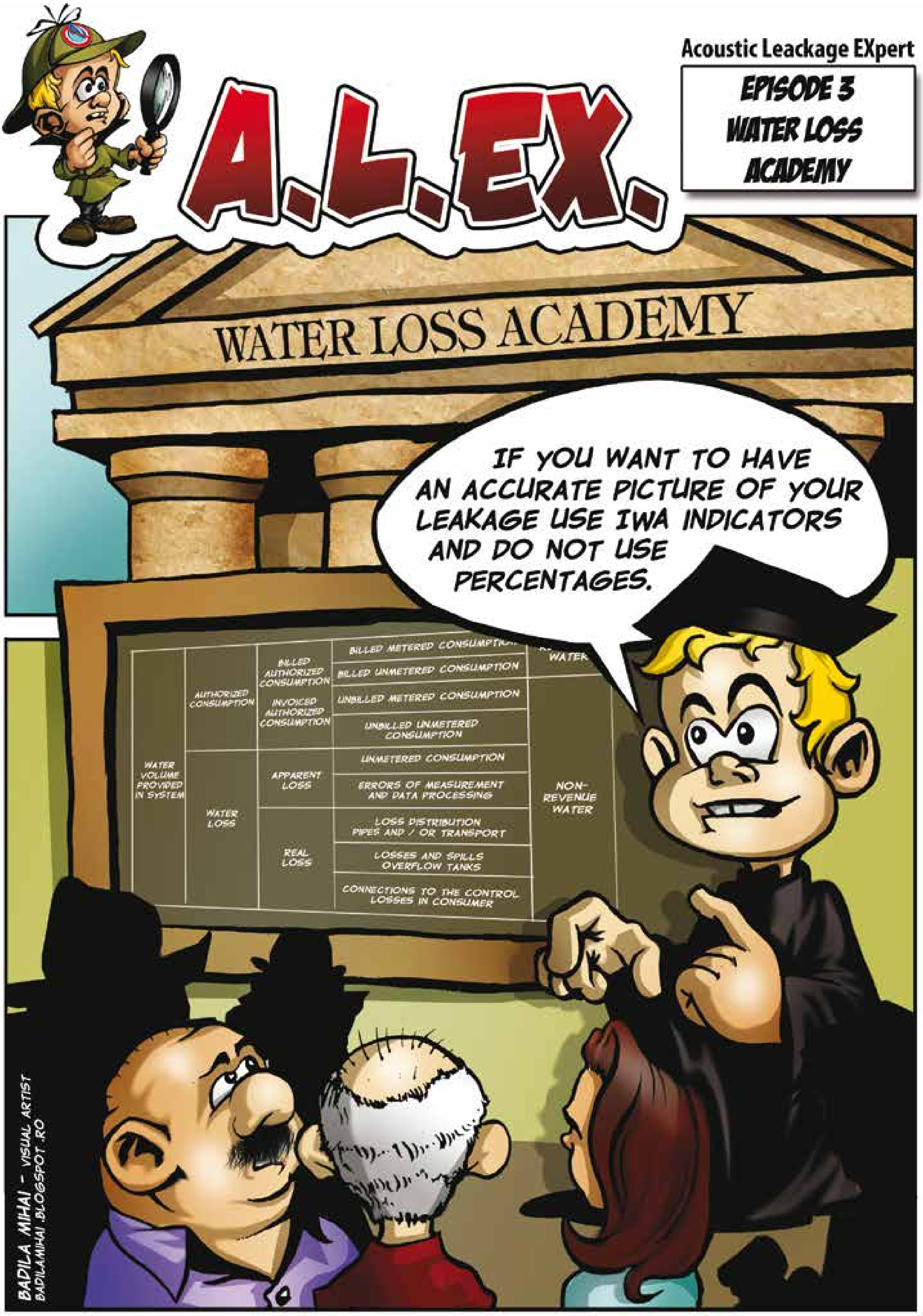
States with Water Loss Regulatory or Policy Framework per AWWA M36 Method (in red)

examples of errors and anomalies such as water loss greater than 100% or less than 0%. These challenges are largely attributed to the lack of understanding for the auditing process (as many utilities are conducting these audits for the first time), quality control on the audit data inputs, and the “top-down” nature of the initial audit. The Delaware River Basin Commission reported that approximately 100 of the 300 audits initially submitted in 2013 were not suitable for analysis, requiring extensive cleanup of errors and anomalies. California reported that among audit submittals from 2010, 36% were unsuitable for analysis due to errors. Texas and Tennessee have reported similar challenges since they began collecting water audits in 2005 and 2007, respectively. In Georgia, a statewide training and data validation initiative was conducted for the 200+ water systems subject to the water auditing and reporting requirement beginning in 2012, in recognition that the presence of un-vetted audits and their performance indicators undermines the credibility of the entire dataset, and the auditing process as a whole.

A survey of the regulatory landscape today reveals growing regulatory momentum for Water Loss in the industry, and a foundational need for education, training and validation based in IWA/AWWA methodology. A look back at prior research efforts on this topic reveal that much has changed in a short amount of time. A look ahead at leading indicators such as draft M36 legislation in New Hampshire, M36 policy objectives established in statewide water conservation planning documents in Oklahoma and Hawaii, and the sustained severe drought conditions in Texas and California suggests that we will see an increasing rate of change in the future.

Will JERNIGAN

Will Jernigan is Director of Water Efficiency, in Cavanaugh, Secretary of AWWA Water Loss Control Committee and Chair of AWWA WLCC Software Subcommittee.


Acoustic Leackage EXpert
A.L.EX.
EPISODE 3
WATER LOSS ACADEMY
WATER LOSS ACADEMY
IF YOU WANT TO HAVE AN ACCURATE PICTURE OF YOUR LEAKAGE USE IWA INDICATORS AND DO NOT USE PERCENTAGES.
WATER VOLUME PROVIDED IN SYSTEM
AUTHORIZED CONSUMPTION
WATER LOSS
BILLED AUTHORIZED CONSUMPTION
INVOICED AUTHORIZED CONSUMPTION
APPARENT LOSS
REAL LOSS
BILLED UNMETERED CONSUMPTION
UNBILLED METERED CONSUMPTION
UNBILLED UNMETERED CONSUMPTION
UNMETERED CONSUMPTION
ERRORS OF MEASUREMENT AND DATA PROCESSING
LOSS DISTRIBUTION PIPES AND / OR TRANSPORT
LOSSES AND SPILLS OVERFLOW TANKS
CONNECTIONS TO THE CONTROL LOSSES IN CONSUMER
WATER
NON-REVENUE WATER
BADILA MIHAI - VISUAL ARTIST
BADILAMIHAI.BLOGSPOT.RO

LARGE SCALE WATER LOSS MANAGEMENT IMPROVEMENT PROGRAM IN ZAGREB (CROATIA) WATER DISTRIBUTION NETWORK

Water utility Zagreb (3000km network) distributes water for city of Zagreb, capitol of Croatia, with 850000 inhabitants. Utility started own water loss program with development of advanced hydraulic mathematic modelling in mid '90s but lost some momentum until recently when IWA methodology was implemented in 2008. (featuring pilot zone tests of advanced pressure control application and system analysis). Last year started comprehensive water loss control program and main elements are presented in this paper.

Sustainability and optimisation of existing water supply system are based on the establishment of its oversight and management, which is a strategic goal of the Water supply and drainage utility. The first step will be achieved through implementation of the Water Leakage Management Program (phase 1) which includes the installation of flow meters on the transportation mains with which the system will be divided into several major water supply metering zones. With the construction of metering chambers and use of mainly insertion flow meters, the system is divided in 20 large zones with a range of inlet flow between 40 and 700 l/s.

The aim is to establish monitoring of consumption and water losses, so that the data via remote data transmission system becomes available in the dispatching centre. This part of the project is financed by the funds of the European Bank for Reconstruction and Development (EBRD).

The next step involves the further division of the larger areas (zones) in smaller District Metered Area – DMA, and some of them will be also Pressure Management Areas - PMA, in such a way that the average consumption in each zone is approximately 40 l/s of day inflow. Also size of the DMAs will allow fast and efficient Active Leakage Control activities (seeking and detecting leakages, apparent losses and unauthorised consumption).

Dedicated program implementation was initiated with aim to reduce water losses in the 2013 by 4,6 million m3 compared to the previous 2012. Depending on the dynamics of establishing control of water supply zones and introduction of measurement and analysis will determine the pace and priorities regarding leakage detection (and reduction due to pressure reduction), repair and rehabilitation. The realisation of the first part of the project involves the formation of 13 DMA zones that is in final stage right now, and in 2014 is planned further expansion with 15 new DMAs.

DMAs and PMAs - starting points

Zoning is implemented with the goal of obtaining a satisfactory level of consumption, which allows the conduction of active leakage control (ALC). With the zoning as fine as possible, the number of service connections in one zone is optimized, which results in better losses monitoring and qiucker pipeline ruptures detection. During the process of zoning, it is necessary to maintain the ratio between the costs arising from the construction of a system for monitoring and managing losses, which implies the installation of the measuring equipment, and cost savings that result from the introduction of such a system, so as the cost of construction and equipment does not exceed the effects of savings.

The long time goal is to establish complete control over the 3000 km of water supply system network in the city of Zagreb by the year 2018, with an emphasis on locating and eliminating losses. Partitioning the system into individual zones of control (DMAs) has already started and systematic measures to achieve controlled pressure are being introduced [1].

When defining DMAs, zone limits and boundary valves must be determined and permanently closed and points of entry into the zones and critical points of pressure monitoring in the zones must be defined. Also, the newly established water network dead ends, which are the result of zone boundaries, must be identified and included into the hydrant flushing programme. Zones are formed so that the night flows that provide a satisfactory estimate of unreported losses and pipeline ruptures can be properly monitored while ensuring sufficient quantity and quality of water delivered to consumers.

In cases when, according to hydraulic analysis and initial measurements, pressure management inside DMAs is possible and required (constant or dynamic pressure regulation), zones become PMA (Pressure Management Area). The forming of PMAs implies installation of pressure regulators (pressure control valves) in ports of entries, which depending on consumption within the zones regulate the valves at the entrance to the zones. In this way, uniform pressure distribution in time and space within the zones is provided.

Design of DMA/PMA

The realization of DMA/PMA zones begins with a preliminary determination of possible zones within the water supply system, during which the following parameters were taken into account:

Possibility of exclusion of tall buildings from the zone, because these facilities prevent pressure reduction without affecting the quantity of water delivered to consumers,

The intensity of water flow through the pipelines after reducing the number of entrances to the zone, in order to ensure satisfactory water quality,

The significance of water losses due to leakage of pipelines, in order to give priority to critical areas of the water supply system,

The possibility of isolating the zone from the rest of the system, in order to ensure the accuracy of measured data, Critical pressure values, which are the cause of system failures and excessive leaks into the ground,

Urban positioning of the ports of entrance and the ports of exits in the zone and the design of the valve chamber with associated instrumentation and control equipment for the measurement and control of flow and pressure,

Asignment of the pressure measurement points and installation of pressure gauges within the boundaries of the zone [2].

Our project on which the implementation of the DMA/PMA zone is based contained:

The exact location of the new valve chambers in which the instrumentation and control equipment will be located,

Position of the newly established water network dead ends included into the hydrant flushing programme,

Structural and mechanical project of the valve chamber; the size of the chamber depends on the dimension of the pipeline,

The means of powering the instrumentation and control equipment, with an emphasis on suggestion of the means of powering, prediction of the necessary additional equipment whose position should be defined in the nearby area, obtain general approval of the other utility companies in whose area of jurisdiction construction of new valve chambers will be carried out (Electric company , Gasworks , etc. ..),

An example of a wiring diagram of instrumentation and control equipment installed inside the metering and regulating inlet chamber.

- Mathematical model of the DMA/PMA and hydraulic analysis of the zone based on the mathematical model, from which the conclusions of the pressure distribution within the zone and the state of water quality within the zone was analysed.

To confirm the quality of the assumed parameters of the defined DMA/PMA zone, measurements of flow and pressure were carried out with help of mobile keasuring and data logging instruments. These measurements were firstly conducted in a situation of a completely opened system, and then followed by a situation where the system is supplied exclusively through the inlet pipeline(s) at the defined point(s) of entry.

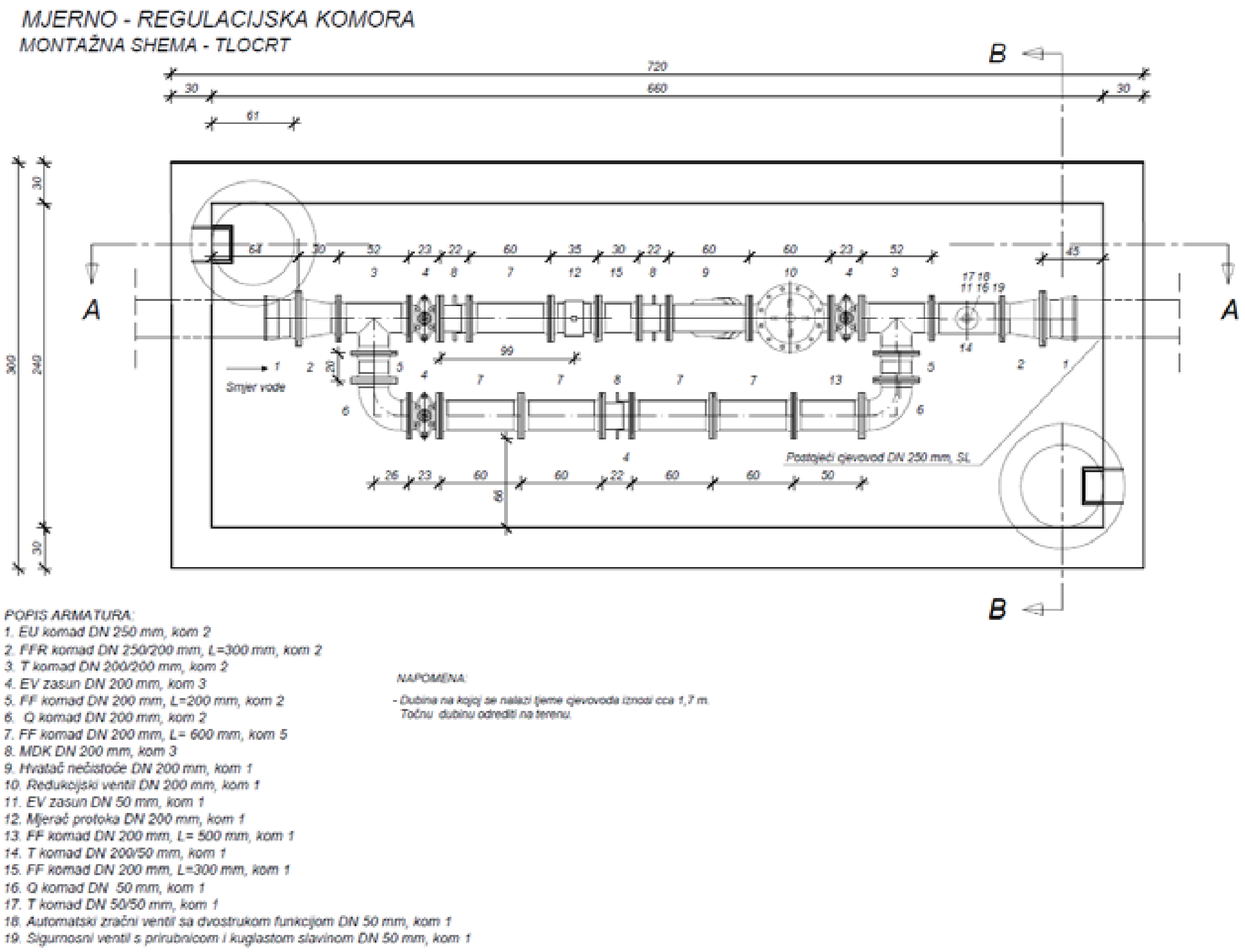
Detailed design included:

Analysis of the current and the prediction of the future hydraulic conditions within the DMA/PMA ,

Structural project of the point of entry chamber(s), with all static calculations and designs of reinforcement and formwork included,

Mechanical design (installation works) in which the mounting scheme for each metering point was displayed separately,

Electrical project with detailed installations of the power supply of instrumentation and control equipment, automatic pressure control, equipment for data transmission, etc. ,



Cost estimates.

The project includes procedure for testing and commissioning the system for regulating the pressure described in stages below:

Closing all boundary valves on the edges of the pressure regulating area,

Supplying the area only through the pressure control valves,

Initial setup of the pressure control valve and automatics,

Installation of flow meters and pressure gauges for the analysis of pressure in the area,

Work check and fine-tuning of the pressure control valve and automatics,

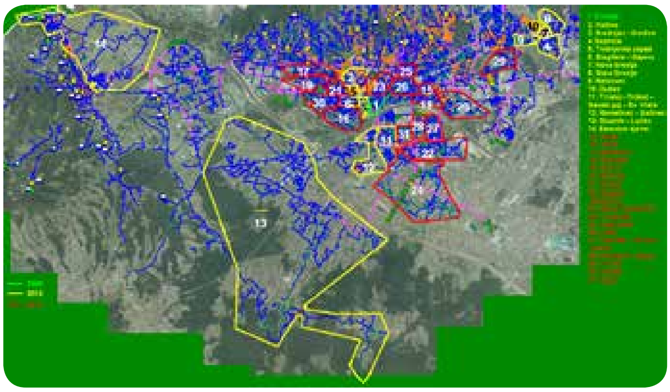
Continuous monitoring and analysis of measurements in the pressure regulating area,

Determining the effects of pressure regulation,

Putting the DMA/PMA into continuous operation.

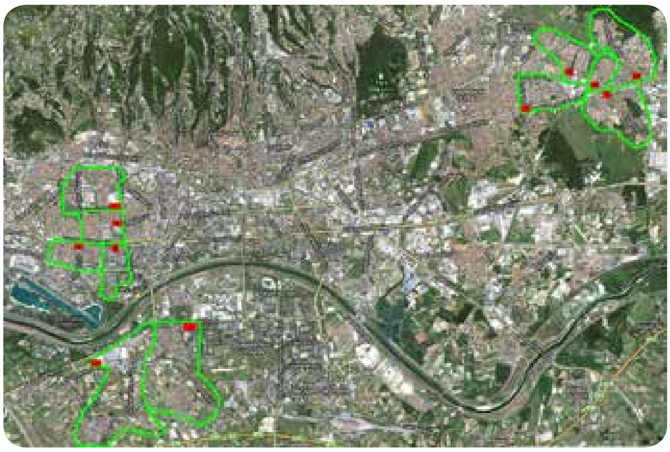
A DMA/PMA zone with marked peripheral chambers in which boundary valves will be closed

Implementation



View of the planned and executed DMA/PMA zones in the water supply system of the city of Zagreb 2008 – 2013

An example of a chamber during construction. Ready-made industrial metal formwork is used for concreting.



View of the DMA/PMA zones realized during 2013. with entering points; measuring/regulating chambers

An example of the installation of already combined instrumentation and control equipment inside the inlet chamber with a crane.

Peripheral chambers of the defined DMA zone in which boundary valves will be closed are marked on the Geographic Information System (GIS) map. The closing of the boundary valves is conducted in order to isolate the DMA/PMA zone from the rest of the water supply system, ie to establish the water inlet to the zone through the monitored point of entry in the new valve chamber.

An example of a waterproofing coating of a constructed chamber, just before the final rehabilitation of the public surface on which it was built.

Results

Implementation (construction works and equipment installation) of DMA/PMAs lasted during 2013 and in second half of the year we have initiated functioning of pressure control in PMA. Following initial measurements in zones, Active Leakage Control campaign was initiated that becomes continuous activity with aim to reduced all real losses and keep them under control. These activities will result in further savings of water.

Reduction in pressure resulted in reduction of losses in particular zones what is presented in following table (note: in zone "Tresnjevka zapad" also conducted leak detection and repair what resulted in additional savings).

Presented measures, and improving the efficiency of the maintenance activities (implemented as separate program of improvements in the utility), resulted in reduction of real losses by 3.3 million m3 in 2013, compared with 2012. (reduced volume of real losses by 6,49%). Main figures of water balance are presented in the next table (volumes in m3).

No	DMA/PMA ZONE	Inlet press. before		Inlet press. after		Flow before		Flow after		Leakage before	Leakage after	Savings	
		min. (bar)	max. (bar)	min. (bar)	max. (bar)	min (l/s)	max (l/s)	min (l/s)	max (l/s)	m3/day	m3/day	m3/day	m3/year
1	DMA/PMA VOLTINO	6,41	7,07	5,45	5,45	33	70	25	65	2.614	2.160	454	165.564
2	DMA/PMA TREŠNJEVKA ZAPAD	4,50	6,53	5,00	5,00	18	24	7	15	1.426	605	821	299.592
3	DMA/PMA STAGLIŠĆE-GAJEVO	5,21	6,7	5,1	5,1	12	37	5	31	950	432	518	189.216
4	DMA/PMA SREDNJACI-GREDICE	5,35	6,94	5,33	5,33	19	52	10	49	1.505	864	641	233.892
5	DMA/PMA REMETINEC-BOTINEC	6,59	7,43	5,5	5,5	12	44	10,5	39	950	907	43	15.768
6	DMA/PMA TRNSKO-TROKUT-SAVSKI GAJ-SV. KLARA	7,07	7,65	5,37	5,37	14	40	4	37	1.109	346	763	278.568
7	DMA/PMA RETKOVEC	5,6	6,4	5,1	5,1	6	17	4	15	475	346	130	47.304
											Total m3/year		1.229.904

Table 1: PMA zones with results in savings

Year	SIV	RW	NRW		RL
2012	120.710.125	59.932.216	60.777.909	50,35%	51.439
2013	114.534.538	57.532.383	57.002.155	49,77%	48.101
Change	6.175.587	2.399.833	3.775.754	0,58	3.338
	5,12%	4,00%	6,21%		6,49%

Table 2: main water balance figures in 2012 and 2013

'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE						
CheckCalcs - a free software for identifying Leakage and Pressure Management Opportunities						
CheckCalcs	Developed	Version 3a	29th Aug 2010	Europe	EUR.0001	© ILMSS Ltd
THIS WORKSHEET SHOWS IWA BEST PRACTICE PERFORMANCE INDICATORS FOR NRW, APPARENT LOSSES AND REAL LOSSES						
Colour coding	Data entry	Calculated Values		Default Values	Data from another Worksheet	
Type of PI ↓	European Master Copy		eb water utility Cr	01.01.2013	to	01.01.2014
Operational management of Non Revenue Water	Non Revenue Water (NRW)				1643,9	litres/service connection/day
	Unbilled Authorised Consumption				83,4	litres/service connection/day
	Apparent Losses				11,1%	% of Billed Metered Consumption
	Real Losses	Best PI for Metric Benchmarking			15,68	Infrastructure Leakage Index ILI
		Best PI for Process Benchmarking			1387,2	litres/service connection/day
Financial	Non Revenue Water (NRW)				49,8%	of System Input Volume
					51,2%	of Water Supplied

Table 3: Performance sheet from CheckCalcs software shows main PI for Zagreb utility

Interesting to notice is that NRW in volumes has significant reduction between 2 years but presented as % from SIV (System input volume) change is minor (from 50,37% to 49,77%) – change in %s is small due to reduction in RW (Revenue water). This shows clearly that NRW in %s should not be used as main indicator in water loss reduction strategy [3].

Also we have calculation of IWA performance indicators that are now recognized as relevant information for future planning of our programs and expected results. Here is presented table from program CheckCalcs with main indicators for 2013.

Conclusion

Since the implementation of the strategic goal of 10 DMA zones in one year (in 2013 we succeeded implementing 13 zones), the project activities have been initiated for further 17 zone that will start with implementation later this year. DMA design process is defined by 3 stages; modelling (with use of GIS, Epanet and visual inspections), test measurements (with mobile flow and pressure meters) and final design preparation (including measuring/pressure control chambers). By the end of 2014 we have a plan to establish 30 DMAs (many of them PMAs) in our network.

All activities are conducted exclusively through internal human and material resources (construction and installation works were done by external contractors), and represent a major breakthrough in current management and maintenance practice under the jurisdiction of Branch Water Supply and Drainage. Further maintenance, rehabilitation, reconstruction and replacement of selected pipelines will be outcomes from the knowledge that follows the analysis and management of DMA zones.

Kristijan ILIČIĆ
Jurica KOVAČ
Vlado HERCEG
Berislav BOHATKA
Mario MEDVEN
Ivan GRDENIĆ

The authors work for Water Supply and Sewage d.o.o., Patacickina 1b, Zagreb, Croatia, and Aqua Libera d.o.o. Ribnica 146c 10415 Novo Čiče, Croatia.

Contact: kristijan.ilicic@vio.hr jurica.kovac@mail.com

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