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IMPACT OF PRESSURE MANAGEMENT ON REDUCING NON-REVENUE WATER

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Supporting organisations: RAND WATER, PM, WRP

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Introduction to Non-Revenue Water (NRW)

Non-revenue water refers to the amount of treated and distributed water that is lost or remains unaccounted for within a water distribution system before it reaches the final consumers.

These losses can be broadly categorized into real losses and apparent losses:

Real Losses: These are physical losses of water from the distribution system due to leaks, bursts and other infrastructure failures.

Apparent Losses: Apparent losses refer to water that is inaccurately measured or billed often resulting from metering errors, theft, unauthorized consumption or illegal connections.

Unbilled Authorized Consumption: is the portion of water use that is authorized by the water utility but not billed to the customer. It is water provided for purposes such as firefighting, street cleaning, public parks irrigation or even supplied to indigent consumers for free.

The relationship between pressure and non-revenue water (NRW) is crucial because higher pressure in a water distribution system often leads to increased real water losses, such as leaks and bursts. This is especially true in systems with aging or poorly maintained infrastructure. Elevated pressure intensifies the volume of water lost, which significantly contributes to NRW.

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Understanding Pressure Management

The process of controlling water pressure within a distribution network to ensure optimal performance. It mostly involves the use of Pressure Reducing Valves (PRVs) and Isolation Valves installed in specific configurations.

The PRV configurations are:

- Single PRV Installation: used in simple setups, where a single PRV is installed in line with the pipeline.
- Parallel PRV Configuration: used in systems with varying flow rates, where multiple PRVs can be installed in parallel, each set to handle different flow ranges. This ensures the system can manage both low and high flow conditions effectively.
- Series PRV Configuration: used in systems where a high reduction in pressure is required where the reduction ratio surpasses 1:3, a step down PRV is Installed to reduce a portion of the pressure so that the second PRV drops the remaining pressure.
- Redundant PRV: A backup PRV can be installed in parallel or in a bypass arrangement for redundancy, ensuring continuous operation during maintenance.

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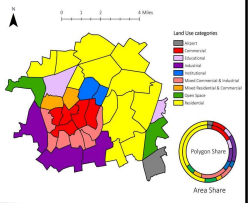
Techniques used in Pressure Management - Zoning

- Dividing the network into smaller zones with controlled pressure levels.
- Zoning is the practice of segmenting a water distribution network into smaller, more manageable areas (zones), each with its own pressure control system. These zones are typically established based on topographical features, demand patterns, or existing infrastructure. The primary purpose is to optimize and maintain appropriate pressure levels across different parts of the network, ensuring that each zone receives the required pressure without exceeding safe limits.



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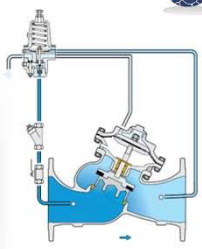
Techniques used in Pressure Management - PRVs

- PRVs automatically reduce the high incoming pressure from the supply side to a lower, more manageable pressure on the downstream side.
- This helps prevent excessive pressure, which can cause leaks, bursts, and damage to the infrastructure.



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Techniques used in Pressure Management – Active Pressure Control

- Uses real-time data to dynamically adjust pressure based on demand.
- PRV controllers manage the outlet pressure of the valve by adjusting it according to predefined criteria. These criteria can include time-based schedules (e.g., reducing pressure during low-demand periods like nighttime)
- The PRV has two pilots and an actuator, the one pilot is set for peak demand and the other one is set for Minimum Demand.

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Techniques used in Pressure Management – Leak detection

- Identifies and repairs leaks to minimize pressure-induced losses.
- Leaks create a pathway for water to escape, which leads to a reduction in the pressure that can be maintained in the system. Leaks can also cause variations in the pressure-leakage behaviour, depending on the size and type of the leak as well as the material of the pipe. For instance, cracks or holes in different pipe materials can exhibit varying responses to changes in pressure, which further complicates pressure management and leak detection efforts.

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Techniques used in Pressure Management – Flow Modulation

- Adjusts flow rates to manage pressure during varying demand.
- The valve actuator allows the right flow rate by using feedback and control signals to open and close the valve.
- Some advanced controllers adjust the PRV pressure dynamically based on the flow rate, accounting for frictional head loss that occurs at higher flow rates. This ensures that the pressure is optimized for current conditions.

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Case Study: Hercules West PRV

Hercules West Reservoir feeds the suburbs in the Northwestern Pretoria Namely:

- Lady Selbourne
- Magaliesmoot
- Kirkney
- Andeon
- Booysens

According to the CoT Water Master Plan two new pressure reducing valves (PRVs) should be installed in the Hercules West Reservoir Zone. The Proposed PRV zone will represent 43% of the Consumers in the Reservoir zone. (2200/5150=43%).

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Case Study: Hercules West PRV

PRV Zone Name	Persons/ house	No. Properties	No. Connections	Estimated Populatio n	Length of mains (km)
Hercules West Res PRV Zone	3.5	2200	2200	7700	37

The objective is to reduce leakage in the water reticulation network through pressure management. Additional benefits of pressure management will include reduced burst pipes and extending the useful remaining life of the water infrastructure.

The Shaded part on the right is the area to be rezoned as the PRV Zone. Two PRV's are Constructed, the one to drop the pressure in the main line on Market Street & Denyssen Road.

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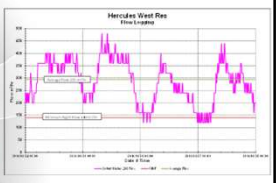
Case Study: Hercules West PRV

The reservoir zone in 2016 had a minimum night-flow of 140 kl/hr and this week its stands at 240 kl/hr

Zone Name	Average Night Zone Pressure (m)	Logged Minimum Night Flow (m³/hr) (1)	Estimated Background Losses (m³/hr)	Estimated Normal Night Use (m³/hr)	Expected Night Flow (m³/hr) (2)	Excess Night Flow (m³/hr) (1) – (2)
Hercules West Res PRV Zone	97	85	28	5	32	33

- A SANFLOW analysis was Carried out in 2016 showed above the excess night flow in the proposed PRV zone is moderate at 33 m3/hr.
- Assuming 140 kl/hr : 33 kl/hr
- Therefore 240 kl/hr : 57 kl/hr



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Case Study: Hercules West PRV

- PRESMAC software was used to determine the potential water savings from implementing pressure management in a zone

Type of Pressure Management	PRV settings (m)	Zone inflow m^3 / yr	Savings m^3 / yr	Savings R / yr	Construction Cost (R)	Payback Period (month)
Current Situation	n/a	890 616				
Fixed Outlet PRV	45m	682 313	206 740	R 1 224 284	R 18.13 mil	177
Time Modulated	45m Day 40m Night	684 124	215 334	R 1 274 481	R 18.38 mil	173

- Using the potential estimated savings of 206 740 kl/yr
- which is 23.6 kl/hr of the 33kl/hr can be reduced by Pressure Management. (roughly 71.5 %)
- 71,5% of 57 kl/hr **= 41kl/hr is our new target**
- Assuming 140 kl/hr : 206 740 kl/yr
- Therefore 240 kl/hr : **354 412 kl/yr**

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Case Study: Hercules West PRV

- The project cost was estimated R3.57 million and the with payback period being 34 months in 2016.
- The average cost for supplying water was assumed fixed at R6.5/kl and the price for selling water at R14/kl in 2016
- Currently Rand water is Supplying water at R12.68
- The project was estimated at R3.57 million in 2016 and was Constructed for R7.3 million in 2024.
- Assuming we are successful in dropping the water losses by 71.5%
- 354 412 kl/yr * R12.68 = R 4 493 944.16 /year
- The Current estimated payback period is 20 months for the Project

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Case Study: Hercules West PRV

The City has other ongoing Programs to deal with the remaining excess night flow of 9.4 kl/hr in the PRV Zone and the entire Reservoir zone Namely:

1. Meter Audits in the entire Reservoir Zone
2. Physical Leak Detection
3. Active leak Detection in partnership with the City of Aarhus from Denmark
4. A Dedicated leak detection Team
5. Updated San-flow Analysis in partnership with WRP & City of Aarhus
6. Commitment by Operations teams to fix all leaks in 48 hours.

The City of Tshwane intends to use the results of the Hercules project to build a Business case for other zones in the City. Once the results start coming Out, they can be used to support the implementation of the project in other Zones.

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Case Study: Waterkloof PRV

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Challenges in Implementing Pressure Management

- Complexity of Network Configurations.
- Old Infrastructure.
- Variability in Demand Patterns.
- Cost of Upgrades.
- Data Accuracy and Availability.
- Vandalism.
- High leak Response Time.
- Technical Expertise.

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Economic Impact of Pressure Management on NRW Reduction

- Cost Savings: By reducing water losses through leaks and bursts, municipalities save on the cost of water production and treatment.
- Reduced Maintenance Expenses: Lowering pressure minimizes the frequency of pipe bursts, leading to reduced repair and maintenance costs.
- Improved Revenue Collection: Decreasing NRW allows more water to be billed, increasing revenue for municipalities.
- Investment Efficiency: Funds can be redirected from constant repairs to infrastructure upgrades and other critical areas.

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Environmental Impact of Effective Pressure Management

- Lower pressure reduces the energy needed for pumping water through the system. This leads to lower greenhouse gas emissions associated with energy production, contributing to a smaller Carbon footprint.
- By lowering the pressure in the distribution network, pressure management significantly reduces leaks and bursts, leading to less water wastage. This helps in conserving water resources, which is especially critical in regions facing water scarcity.

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Conclusion and Recommendations

- South Africa is experiencing aging infrastructure, which complicates the implementation of pressure management strategies. Frequent leaks and bursts are common, making consistent pressure regulation difficult. The use of Grants and Public-Private Partnership (PPP) projects may avert limited financial resources and technical expertise that often hinder the adoption of advanced pressure management technologies.
- Municipalities must appoint qualified professionals to derive solutions tailored to address the specific challenges of local communities, including varying demand patterns and network complexities. High levels of NRW due to leaks and unauthorized connections are prevalent, and pressure management is critical in reducing these losses.

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Get The Basics Right

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THANK YOU

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