Delivery of30 Ml/d Leakage Reduction ThroughIntelligent Pressure Control

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Introduction

The increasing pressure on global resources continues, and will continue to do so until appropriate engineering solutions and technologies are developed to meet the needs. The UK based, venture capital funded company, i2O Water ltd, are proving how this can be done to the benefit of both water companies and their customers.

Often excess pressure exists in distribution networks. This can lead to excessively high levels of leakage on the network and poor pressure being experienced by the customers.

The i2O solution is an integrated system of wireless remote sensors and controllers, centralised server architecture, intelligent learning algorithms and a web interface for remote monitoring and control. The controllers are installed on both existing variable speed drive pumps and Pressure Reducing Valves (PRVs). The intelligent learning algorithm uses the pressure and flow data from the remote sensors to model the characteristics of the network. After developing the operating model it continues to update continuously, adapting automatically to changes in the network characteristics that occur for many reasons including; changes in customer demand, network re-zoning, seasonal weather influence and changing industrial usage patterns.

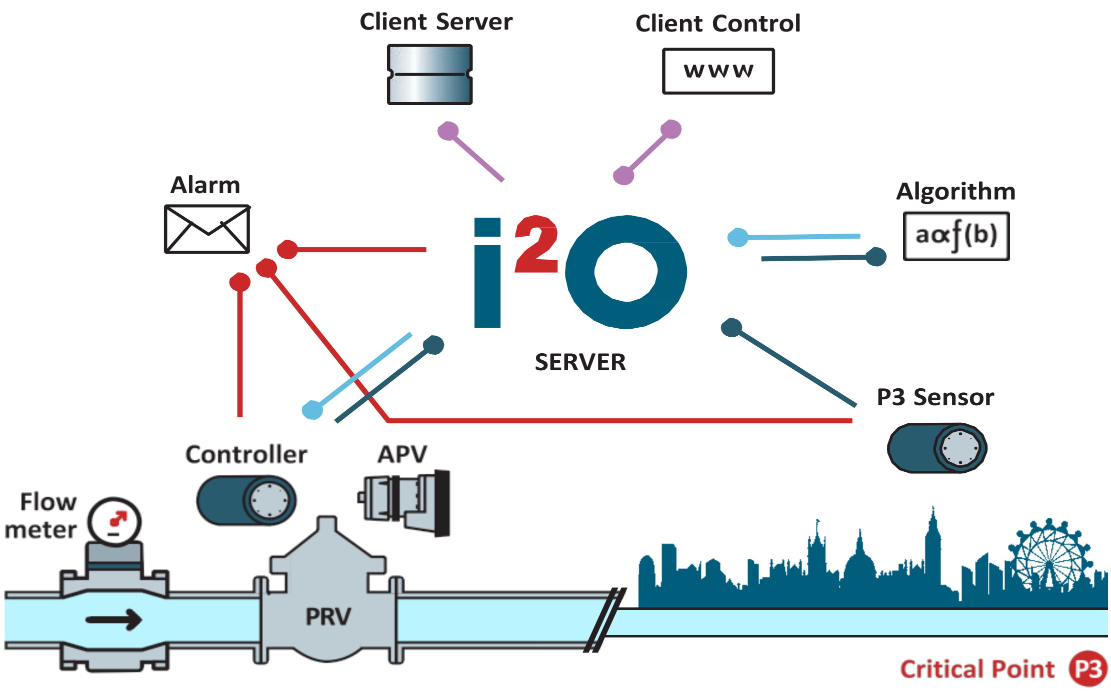

Figure 1.1i2O System - PRV control application

Since early 2010 i2O have been working with SYABAS and JalurCahayaSdn Bhd to improve the water resources availability whilst lowering network operating costs through the deployment of their controllers. This work has been delivered in three stages with performance closely monitored and key to the success and continuation of the project work. These three phases are outlined here, with a summary of results to date presented.

Phase One

i2O Water was met with the initial challenge to deliver a 10 Ml/d reduction in water being supplied in the Malaysian state of Selangor, an area supplied by SYABAS. For this first phase , 50 District Metered Areas (DMAs) were selected covering 47,000 connections. The total daily flow into the 50 DMAs averaged 99.6 Ml/d, with Non-Revenue Water calculated at 39.4%. The overall leakage reduction required was from 39 Ml/d to 29 Ml/d, representing a 25% saving.

All of the DMAs had existing Pressure Reducing Valves (PRVs) installed, which were previously set to either fixed outlet or modulated control. i2O systems with automated PRV control were installed on all the DMAs. This unique system enables advanced management of the distribution network and allows leakage to be reduced while maintaining the required levels of customer service for both flow and pressure.

Installation

The installation was carried out by i2O's local partner, non-revenue water specialist company JalurCahayaSdnBhd with technical support from locally based i2O engineers. The project followed a four- stage, planned approach; 1) desk-based feasibility assessment; 2) detailed site survey; 3) installation and commissioning; 4) network optimisation.

Stages 3 and 4 took place from June 2010 to January 2011, and involved the installation, commissioning and optimisation of 50 systems, one in every DMA. Each installation typically took around three hours to complete, including the installation of the remote pressure sensor at the critical point within the DMA. Settings for the field devices are held on the central server and are downloaded automatically the first time that the devices connect over the GSM network. This saves time on site and also enables devices to be further optimised remotely once installed. This means that no more site visits are required to make adjustments to the pressure settings.

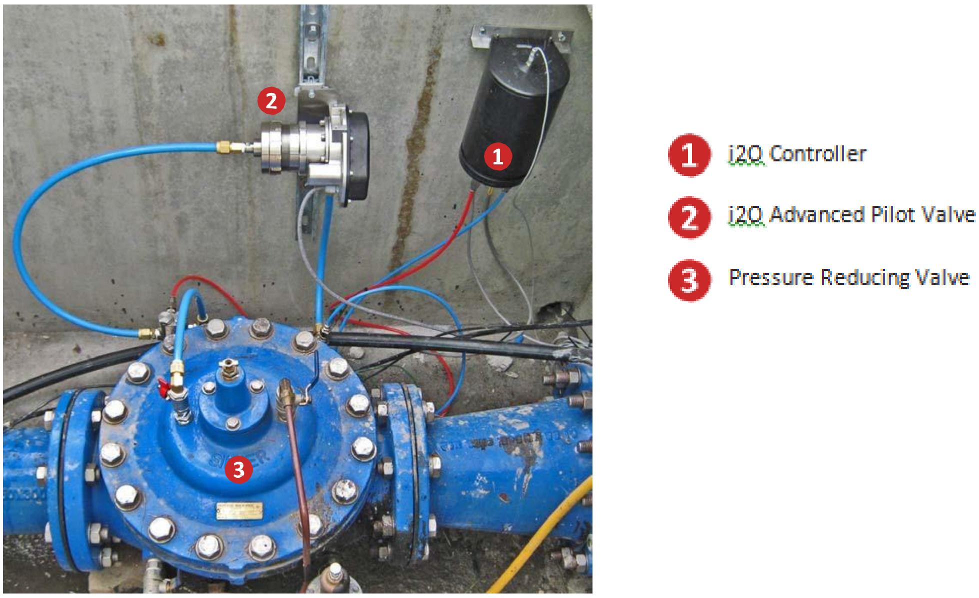

Figure 1.2 Typical i2O System installation

Optimisation

Once installed, all systems have been remotely monitored and controlled using the system control interface through the web- based i2O portal. All of the collected data is uploaded daily to i2O system servers via GPRS GSM networks. Once all of the data from the site has been relayed to servers it is used by the control software.

There are two main parts to the innovative software, the optimisation algorithm and the system control Interface. The algorithm is an artificial intelligence mathematical model which learns the characteristics of the DMA. This operates continuously, and as the network conditions change, it automatically adapts. The i2O system control interface combines a selection of performance indicators, interactive graphs and intelligent alarms, with i2O remote control capability. This enables engineers to access the controller, carry out detailed data review to assess network performance, monitor field work activities being undertaken and even review the performance of the PRV itself.

Initial optimisation takes an average of six to twelve weeks, and each site is different due to the individual characteristics of the valve, the type of control that is required and the distribution network configuration. Following this initial period further optimisation is achieved.

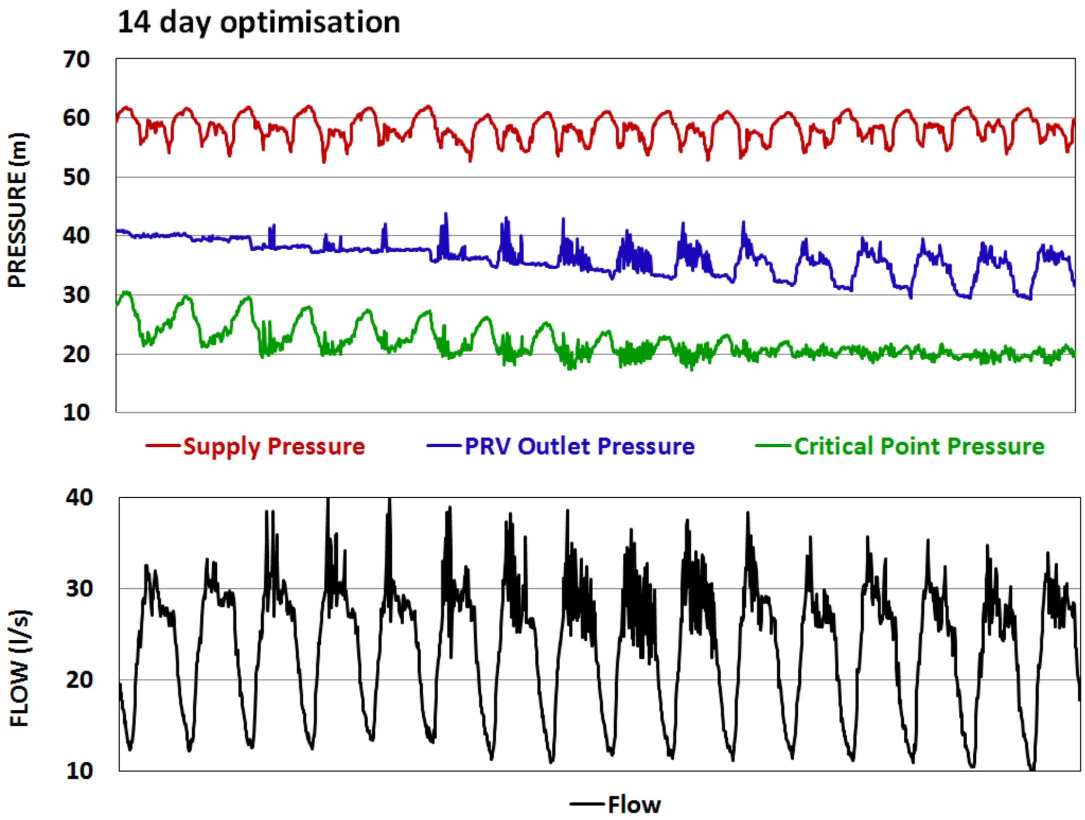

Figure 1.3 System control interface - DMA performance

Phase One Examples

Example 1 - Johan Setia DMA

The Graph below shows the DMA performance in two periods, June 2010 and January 2011. In June 2010 the PRV was initially set to a fixed outlet of 20m prior to the optimisation process starting. The Minimum Night Flow (MNF) averaged 26 l/s and upstream pressure in the network was falling below 20m during periods of demand.

After 30 weeks of optimisation we can see that MNF has been reduced to an average of 9.5 l/s, a reduction of 16.5 l/s or 37%. The PRV is delivering stable, well controlled pressure, with additional night-time reductions in pressure to optimise leakage savings.

In addition to the leakage savings it is also important to observe the effect that the optimisation of this and adjacent DMAs has had on the available upstream pressures. In week one, upstream pressure was not meeting demand, but by week 31 there was significant improvement, with over 30% more pressure in the distribution system.

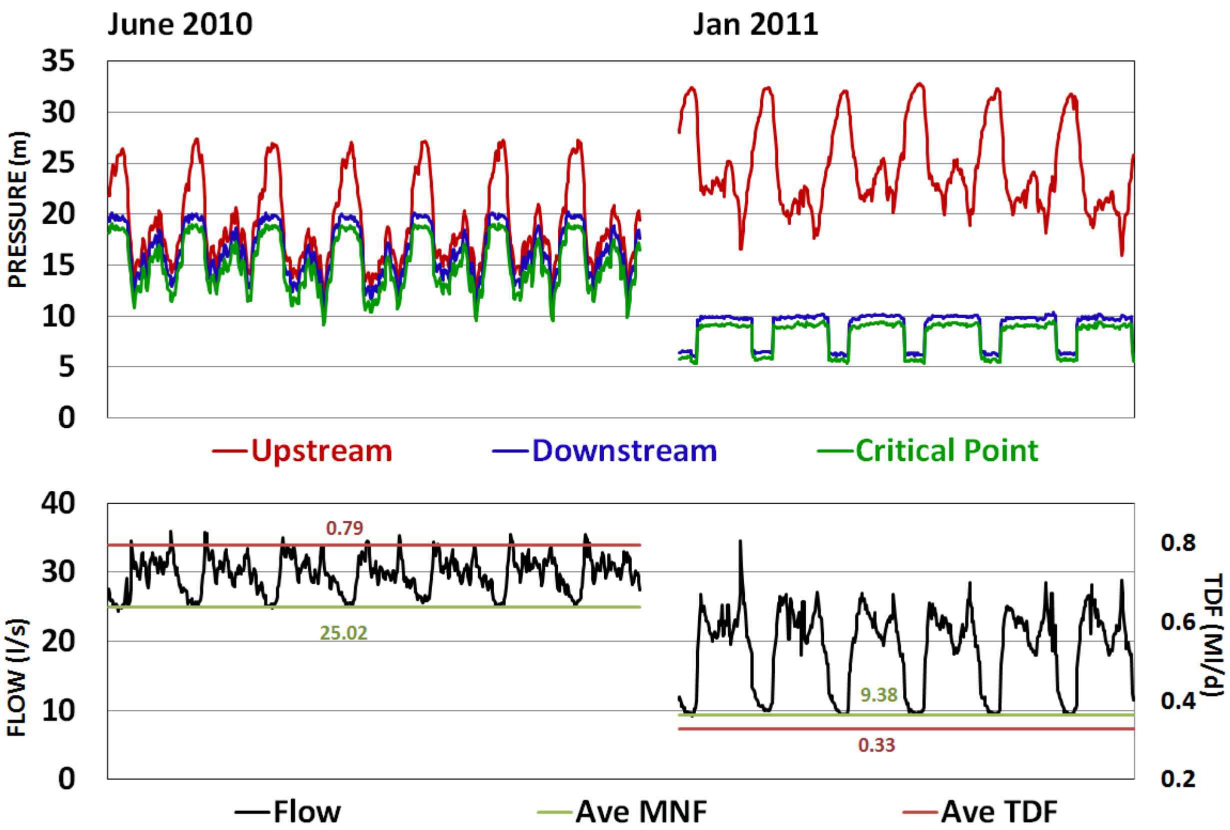

Figure 1.4 Johan Setia DMA summary result

Example 2 - Bandar Botanic DMA

Bandar Botanic is a good example of how an area which was already flow modulated using traditional equipment can be further improved with innovative technology. The graph below shows that in week one the PRV is being modulated to meet demand in the area using the flow data. This results in excess pressure in the DMA, variable pressure at the Critical Point and an average MNF of 20 l/s.

After 28 weeks of optimisation we can see the i2O system is maintaining a steady level of service at the Critical Point by varying the downstream pressures to meet demand. This has resulted in savings inminimum night flow of 45% and total daily flow of 31%.

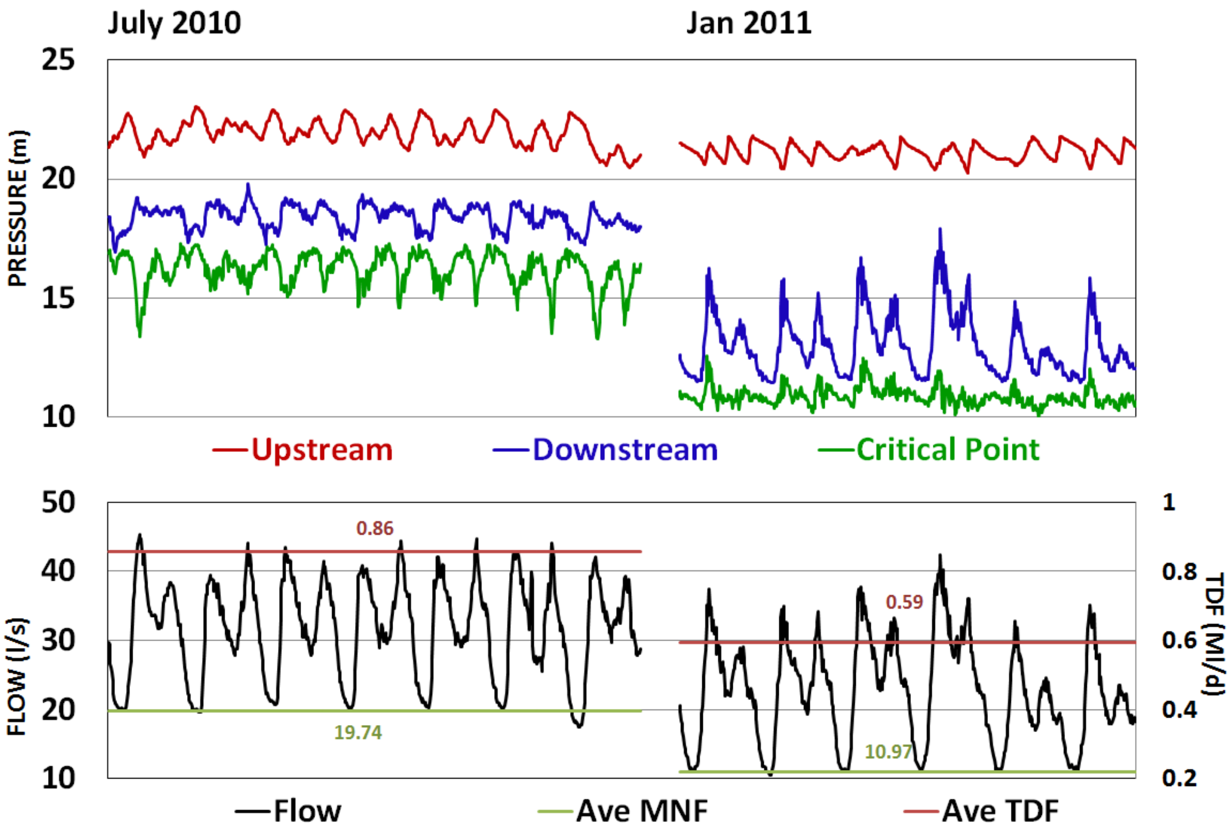

Figure 1.5 Bandar Botanic DMA summary result

Phase One Results

From the 50 DMAs selected for optimisation, wide ranges of interesting network improvements were identified. These included the repair of large burst mains, opening closed valves within the network that cause loss of pressure, closing boundary valves to improve the accuracy of the network data and resolving technical problems with flow meters.

The target of the project was to reduce the 99.6 Ml/d total daily flow in the DMAs by 10 Ml/d. This was exceeded as a total reduction of 10.54 Ml/d has been achieved. With leakage calculated at 39 Ml/d at the start of the optimisation this 10.54 Ml/d saving represents a 27% reduction in leakage.

Phase Two

As a result of the success of the first phase, a second phase of a further 50 PRV control systems was initiated to follow immediately, continuing to deliver the demonstrable improvements. Building on the experience gained from phase one, this second phase was able to deliver significant improvements both in terms of the office based processes and field work activity. This has resulted in the ability to deliver a wider range of pressure management solutions on the network including some complex systems with detailed configuration settings.

The target of the second phase of the project was to reduce total daily flow in the 50 DMAs by 10 Ml/d, the same rate of benefit delivery as seen in the first phase.

Phase Two Examples

Example 3- Taman TAR DMA

The DMA example below shows a network configuration where pressures are optimised tominimise losses whilst maximizing revenue. The controller is set first to deliver a two point control, with different settings for both day and night time. Once the algorithm has become established it is then possible to introduce multi point control, allowing different settings to be applied dependant on various local network conditions, satisfying customer demands and the requirement to reduce leakage.Here we see that the second stage of optimisation delivers an additional leakage benefit whilst maintaining total daily flow levels, with minimum night flow reduced by 28% and total daily flow by 15% overall.

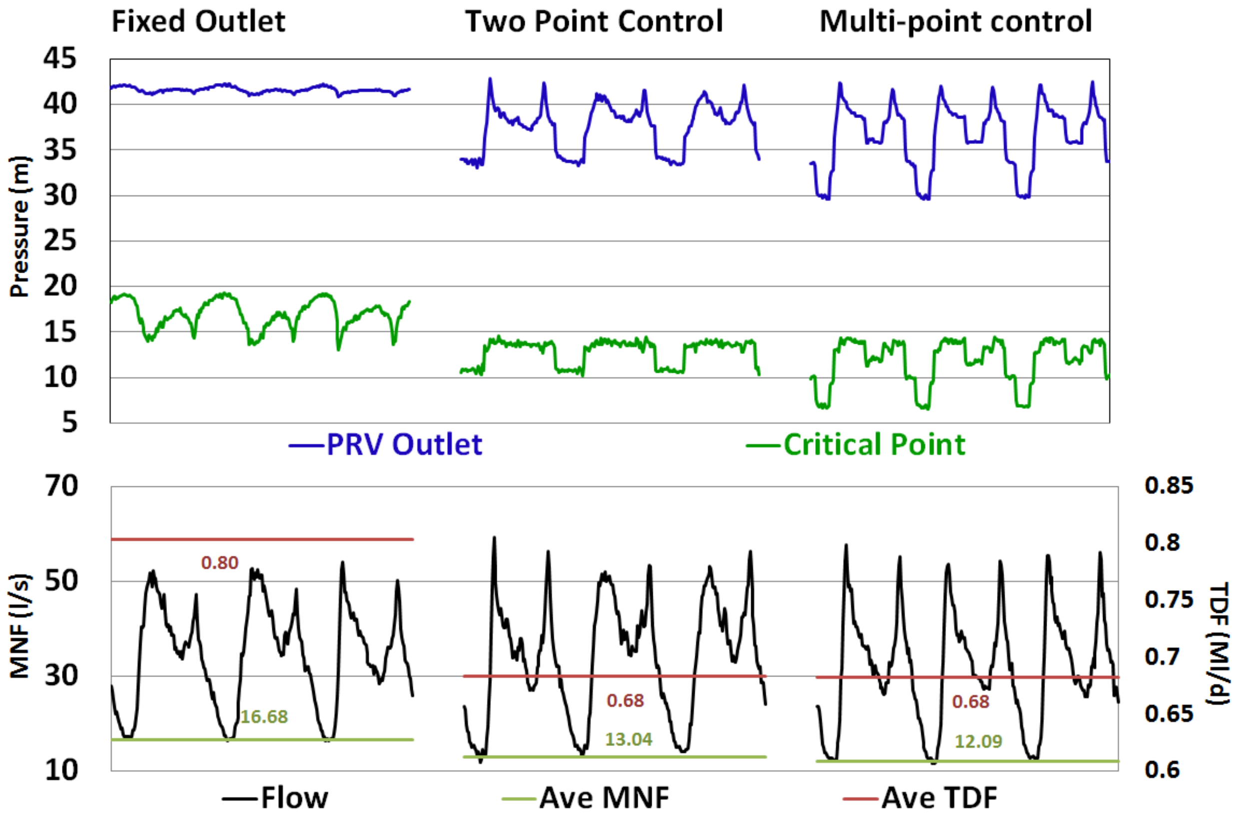

Figure 2.1 Stages of optimisation in Taman TAR DMA

The Multi point control utilises 4 levels of pressure control during six defined time periods across the day. The target pressure delivered at the critical point is set not to drop below:

- 6m at night when demand is at a minimum
- 9m and 11m during periods of average demand
- 13 m during peak demand.

The graph below shows how the outlet pressure of the PRV varies by over 10m, increasing steadily to meet demand whilst ensuring that excess pressures do not occur. It is this smooth control of the network that has a great impact on both the stablelevel of service for customers, and a reduction in the number of burst mains experienced.

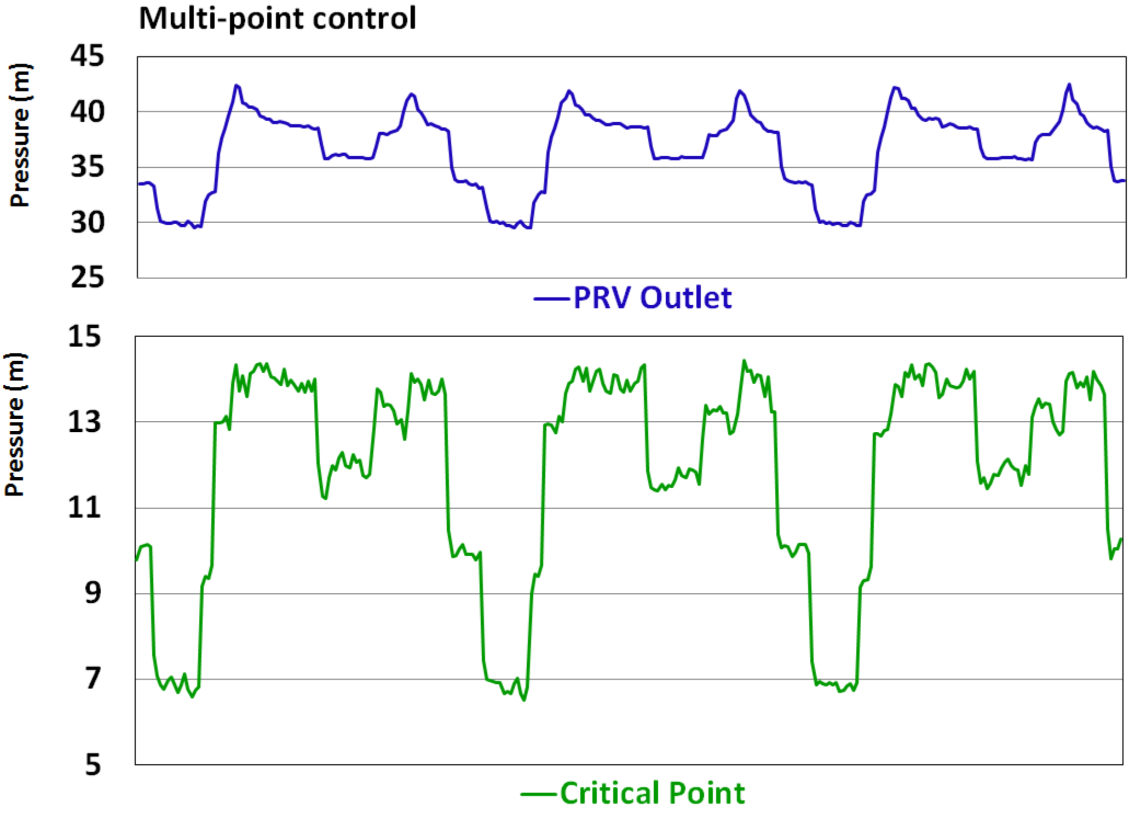

Figure 2.2 Complex control in Taman TAR DMA

Example 4- BaganSekinchan 2

It is not only the DMAs that have experienced improvement as a result of the deployment of the i2O systems across the network. In this example we see how the improved levels of network information and control have led to the identification and resolution of upstream 'zonal' improvements.

In the first phase of the deployment a problem with the configuration of the network was identified. Upstream pressures were demonstrating significant variation, with pressures at peak demand following those within the DMA. This had the effect of making the operation of the PRV very limited in terms of its ability to deliver effective savings. In addition to this customers in this area would have been experiencing very different levels of service throughout the day.

After network investigations were carried out, targeted in and around the area monitored, network configuration improvements were identified. With the support of network operations teams these configuration improvements were implemented, leading to a significant stabilisation being achieved in zonal network pressures.

Further to the improvements made at a zonal level, it was then possible to carry out effective optimisation of the PRV feeding the DMA. Here we see that effective optimised 2 point control has been achieved. Through these improvements leakage has been reduced significantly with minimum night flows reduced by 42% and total daily flow reduced by 45%.

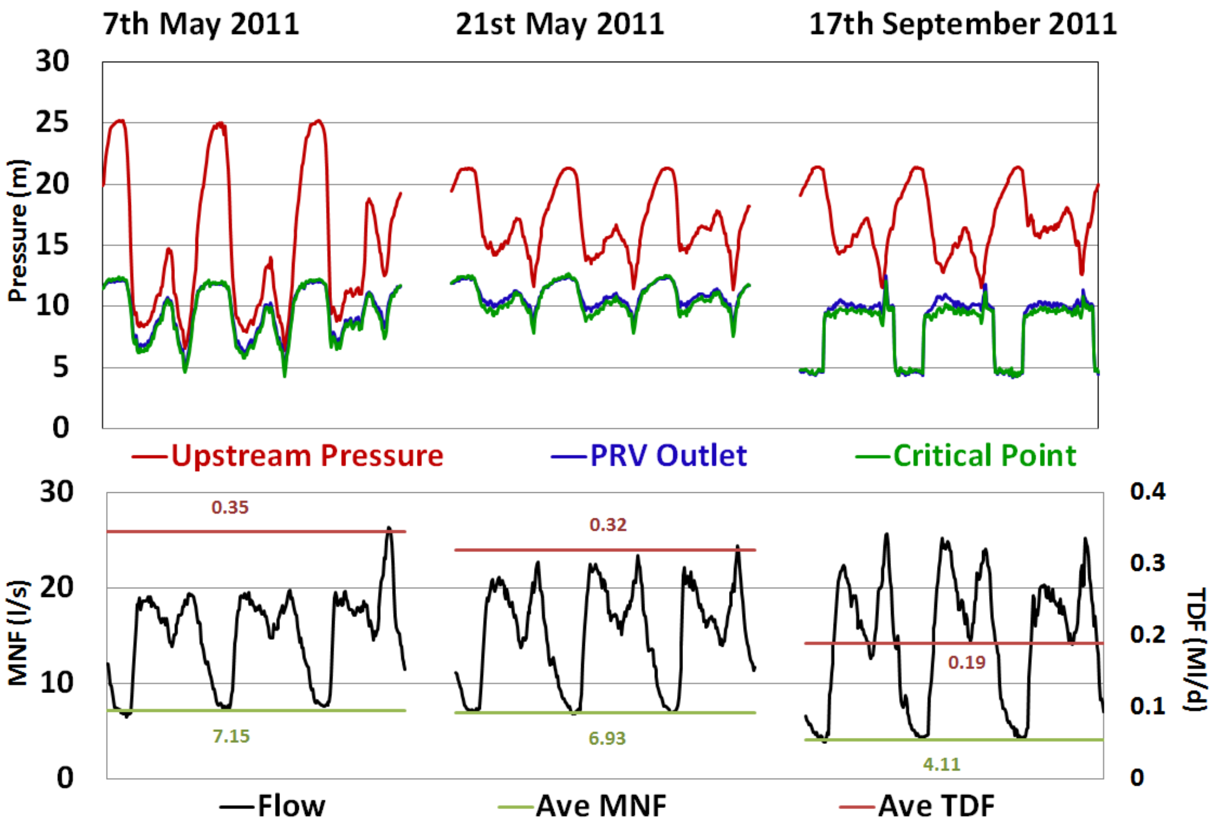

Figure 2.3 Stages of improvement and optimisation in BaganSekinchan 2 DMA

Phase TwoResults

The target of the second phase of the project was to reduce total daily flow in the additional50 DMAsby 10 Ml/d. This has been exceeded as a total reduction of 13 Ml/d has been achieved.

Phase Three

Further deployment of the i2o systems across various Districts of Selangor Stateis underway with an additional 100 sites currently being installed. The target of the third phase of the project is to reduce total daily flow in the area by 15 Ml/d. .

Overall benefits summary

To Date a total of 120 systems have been installed across 10 distribution Districts, delivering total daily flow savings of **32.3 Ml/d**. This represents an average saving of 269 m3/day/DMA or 12.4% across all sites.

DISTRICT	Nos of i2O Installed	Total Daily Flow, TDF (m3/day)		TDF Reduction (m3/day)	% Reduction of TDF
		Before Installation	After Installation		
Gombak	25	56,531	51,560	4,971	8.8%
Hulu Langat	8	16,328	14,185	2,143	13.1%
Hulu Selangor	7	14,859	13,797	1,062	7.1%
Klang	29	69,580	56,229	13,351	19.2%
Kuala Langat	8	17,285	15,328	1,957	11.3%
Kuala Lumpur	1	2,406	2,325	81	3.4%
Kuala Selangor	11	16,684	13,323	3,361	20.1%
Petaling	17	45,997	42,500	3,497	7.6%
Sepang	3	6,932	6,427	505	7.3%
Sabak Bernam	11	14,708	13,298	1,410	9.6%
Total	**120**	**261,310**	**228,972**	**32,338**	**12.4%**

Table 1Summary of savings by District

With so many different DMAs the level of savings can vary considerably from one to another, due to the size, existing levels of leakage and operational stability prior to optimisation. Below we see a histogram of performance of all 120 sites. This shows how the savings achieved have ranged from 20m3/d through to 2.3 Ml/d.

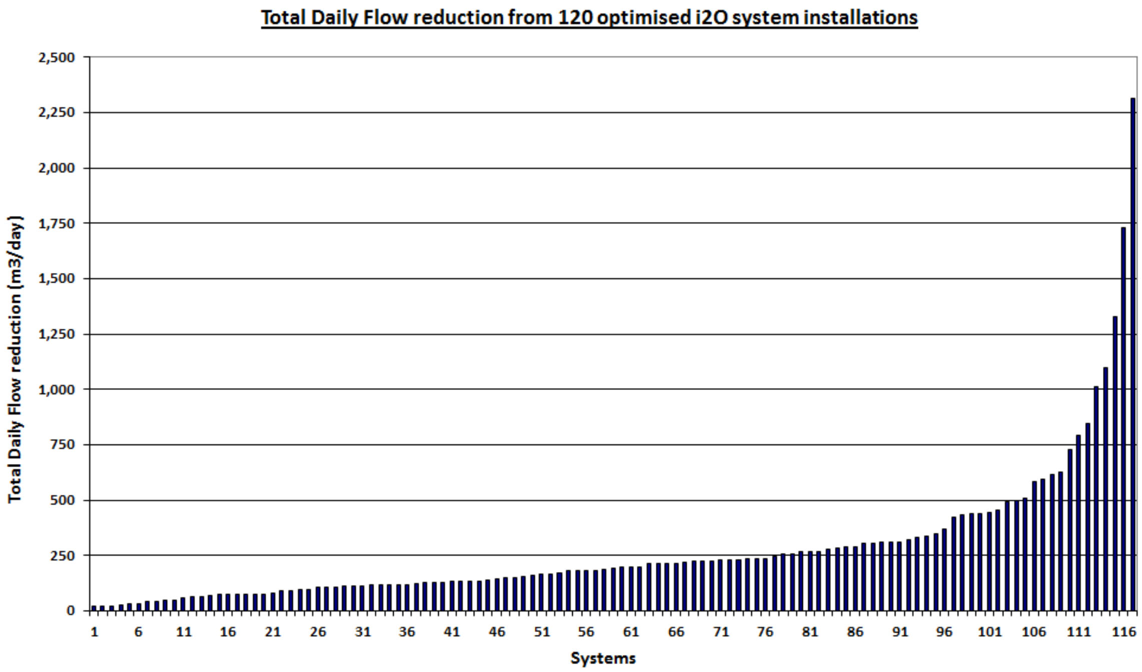

Figure 3.1DMA savings histogram

Considerable savings are also measurable in other network perfomance indicators. The impact of stabalising and control network pressures in combination with the improved data for control and operation of the network has led to significant improvement across all areas. The graph below shows the reduction in reported bursts in both areas with i2O systems installed and the remaining DMAs as a result of the improvements made since the first systems were installed.

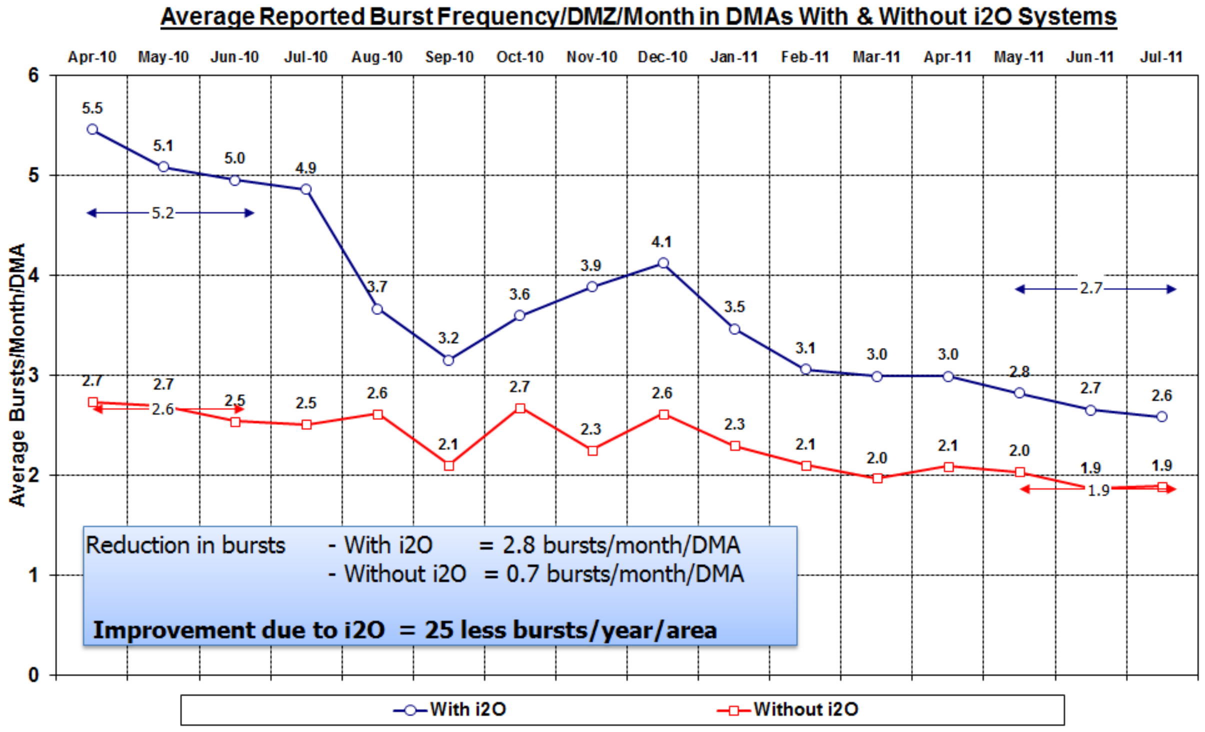

Figure 3.2 Reported Burst Frequency Reduction

Considerable differences can be seen between the two data sets, with the improvements made to date in the areas with i2O systems installed representing a 48% reduction in quarterly average performance from 5.2 to 2.7 bursts per month per DMA. This represents a significant reduction in effort required to operate the network, with efficiency savings being realised through the need to carry out less labour intensive detection and repair activities.

SYABAS is now operating 120 DMAs across 10 of its distribution Districts in an improved way.

The benefits being observed include:

- 48% reduction in pipe bursts
- Further reductions in leakage assystemscontinue to optimise
- Reduced energy costs of treatment andpumping of water
- Improved levels of customer service
- Fewer operational activities required
- Accurate and reliable network data to support decision making
- Flow and pressure alarms generated whenchanges occur on the network