UTS:INSTITUTE FOR SUSTAINABLE FUTURES

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Pressure Management Leak Reduction Assessment

Final Report

Prepared for: South East Water

Prepared by: Institute for Sustainable Futures
University of Technology Sydney

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Mohr S & Mukheibir P, 2015 Improved leak detection method for water reticulation zones, Report prepared for South East Water, The Institute for Sustainable Futures, University of Technology Sydney, June 2015

Executive Summary

The Institute for Sustainable Futures (ISF) was tasked with estimating the actual savings from South East Water's (SEW) installing pressure reducing valves (PRVs) and the establishment of pressure management zones within SEW's potable water distribution network.

ISF used an algorithm (ISF1) developed to detect changes in flow characteristics in a previous SEW project. The algorithm was able to estimate the average daily saving based on analysis of the consumption for 14 days prior and after the switching on of the pressure management zone (PMA) – as shown in the table below. The algorithm implicitly takes variations in weather and other influences into account in the analysis.

For the PMAs with reliable flow data, the analysis indicates approximately 3.7 times higher savings than was estimated by SEW in the project business plan. A simple comparison of the average daily consumption prior and after the intervention (not considering daily variations due to weather etc.) confirmed that the results yielded by ISF1 were of the correct magnitude.

It is likely that in addition to reduced background leakage in the SEW network and on customer side of the meter, a reduction in the volume of water used in showers and indoor and outdoor taps has been observed – resulting in 7-12% reduction in water supplied to the two zones.

Savings by zone (ML/year):

Zone	Average pressure reduction (kPa)	ISF 1 Predicted less Actual metered volume (ML/d)	Estimated annual saving (Ml/year)	Estimated volumetric saving (%)	SEW estimated savings (ML/year)
Montrose Boronia	290	0.100 ± 0.011	**37**	**12 %**	9.5
Mt View Reservoir	150	0.090 ± 0.017	**33**	**7 %**	9.5

Contents:

Abbreviations

DMA	Demand management area
ISF	The Institute for Sustainable Futures, University of Technology Sydney
L/s	Litres per second
ML/d	Mega litres per day
PMA	Pressure management area
PRV	Pressure reducing valves
SCADA	supervisory control and data acquisition
SEW	South East Water Corporation

1 Introduction

This quote is provided in response to the request by South East Water (SEW) to determine a reliable methodology for quantifying the benefits of this work, based on the previous work undertaken by ISF in developing an algorithm for leak detection.

South East Water (SEW) has implemented an initial set of five pressure management areas (PMAs) in order to reduce the level of background leakage in these zones (See Table 1 for details of each PMA). SEW are planning to develop a business case to expand the pressure management program to other zones. A key input to this business case is of how successful the implementation of these PMA's has been.

The Institute for Sustainable Futures (ISF) has been commissioned to estimate the volumetric savings due to the introduction of the PMAs, using the algorithms developed for the SEW in a previous project.

This report describes:

- the approach used to estimate changes in flow
- the results (savings) for each of the DMAs
- a short discussion of key issues and assumptions

Table 1: PMAs information and estimated annual savings provided by SEW

No	PRV	PMA	Original Zone Pressure (kPa)	New PMA Zone Pressure (kPa)	Night Pressure (kPa)	PMA turned on dates	SEW estimated annual saving (ML/yr)
1	WB554 – Warrigal Rd PRV	Notting Hill Reservoir (76 m AHD)	820	520	420	27/03/2015	20.7
2	WB555 – Doysal Road PRV	Montrose Boronia (185 m AHD)	920	630	530	10/03/2015	9.5
3	WB553 – Barkers Road PRV	Mt View Reservoir (137 m AHD)	730	580	480	19/03/2015	9.5
4	WB552 – Frawley Road PRV	Hallam North (115 m AHD)	820	570	470	31/03/2015	18
5	WB551 – Kidds Road PRV						

2 Methodology and approach

The ISF modified the leak detection algorithm (developed for SEW in a prior project) to determine the amount of savings resulting from the pressure reduction. The algorithm (ISF 1) already calculates a predicted consumption based on a scaled and translated production from other closely matched zones. This estimated consumption forms a basis for determining the savings.

This approach implicitly controls for weather/climate, because consumption in the target zone responds similarly to consumption in other similar zones

The method of analysis included:

1. Finding other DMA's with similar consumption in the 14 days prior to pressure-reduction.
2. Fitting a model that predicted the flow in the target zone using the consumption in the other similar zones for the period prior to the implementation of pressure management.
3. Using this model to predict the flow in the target zone after the implementation of pressure management, based on the consumption of the other similar zones.
4. Comparing the difference in the pre-pressure management modelled profile and actual data, with the difference in the post-pressure management modelled profile and actual data.
5. This yielded an estimate of the average daily volume saved over that period.

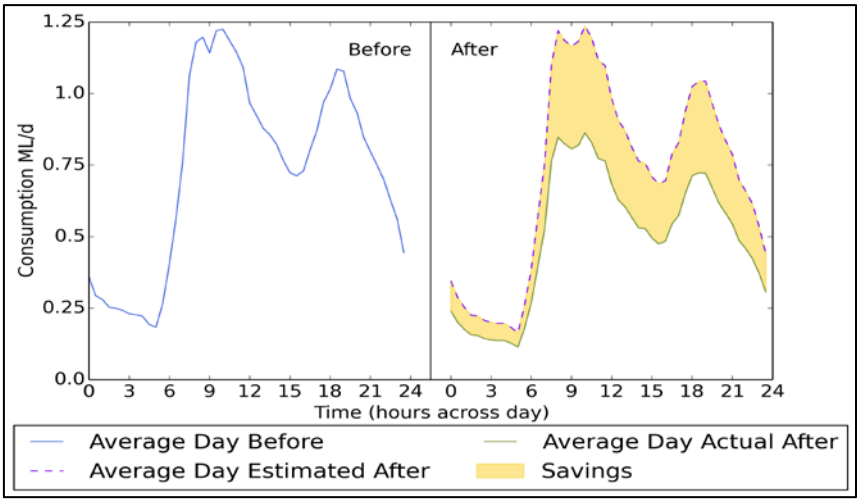

Figure 1: Illustration of how the savings were calculated

The algorithm used in this analysis was ISF1 – while time consuming to run, ISF1 provides a more robust calculation of the difference in consumption before and after a specific date. All the calculations are based off a consistent 14 days pre and the 14 days post intervention.

The formula for the estimated savings is expressed as:
ISF1 Predicted – Actual = difference of differences between the ISF1 predicted and actual in the before and after period.

In addition, ISF undertook a simple calculation of the average daily savings based on the 14 days prior and directly after the intervention, in order to verify the ISF1.

3 Limitations of the analysis

Reducing the pressure in a distribution network has the effect of reducing the water demand in three ways:

- Reduction in network losses
- Reduction in customer leakage
- Reduction in customer consumption due to lower pressures and flows.

The analysis undertaken by ISF only provides and the total water saved. It is not possible to disaggregate the saved water with any certainty into these three areas, based only bulk meter data.

4 Results

The flow meter data provided revealed that the flow meters for the Notting Hill PMA were not working properly during the period before the PRVs were turned on (see Figure 2 in Section 5.1). Hence it was not possible to ascertain the volumetric saving for this PMA.

For the Hallam North PMA, the analysis of the estimated savings indicated a saving of almost 10 times the original estimate in the SEW business plan (See section 5.2), prompting an investigation of the integrity of the zone. It was found by the SEW Operations team, that two valves were not completely closed and were providing unmetered water at higher pressure to the zone. Therefore the results of the savings for Hallam North have been disregarded.

For the remaining PMAs the following two tables provide the outcome of the analysis using ISF1 and the basic analysis. The detailed graphs for each PMA is provided in the Appendix which follows).

The remaining two zones indicate substantially higher saving that was estimated by SEW in the business plan. While the simple analysis does not take weather and other variations into account, the results in Table 3 validate those yielded by ISF1.

Table 2: Average daily savings by zone using ISF 1

Zone	ISF 1 Predicted – Actual (ML/d)	Estimated annual saving (Ml/year)
Montrose Boronia	**0.100** ± 0.011	**37**
Mt View Reservoir	**0.090** ± 0.017	**33**

Table 3: Average daily saving by zone using a simple before and after comparison

Zone	Average daily volume before PMA (ML/d)	Average daily volume after PMA (ML/d)	Difference (ML/d, % change)
Montrose Boronia	0.76	0.67	**0.09** **12%**
Mt View Res	1.39	1.30	**0.09** **7%**

5 Appendix: Figures for each PMA

5.1 Notting Hill PMA

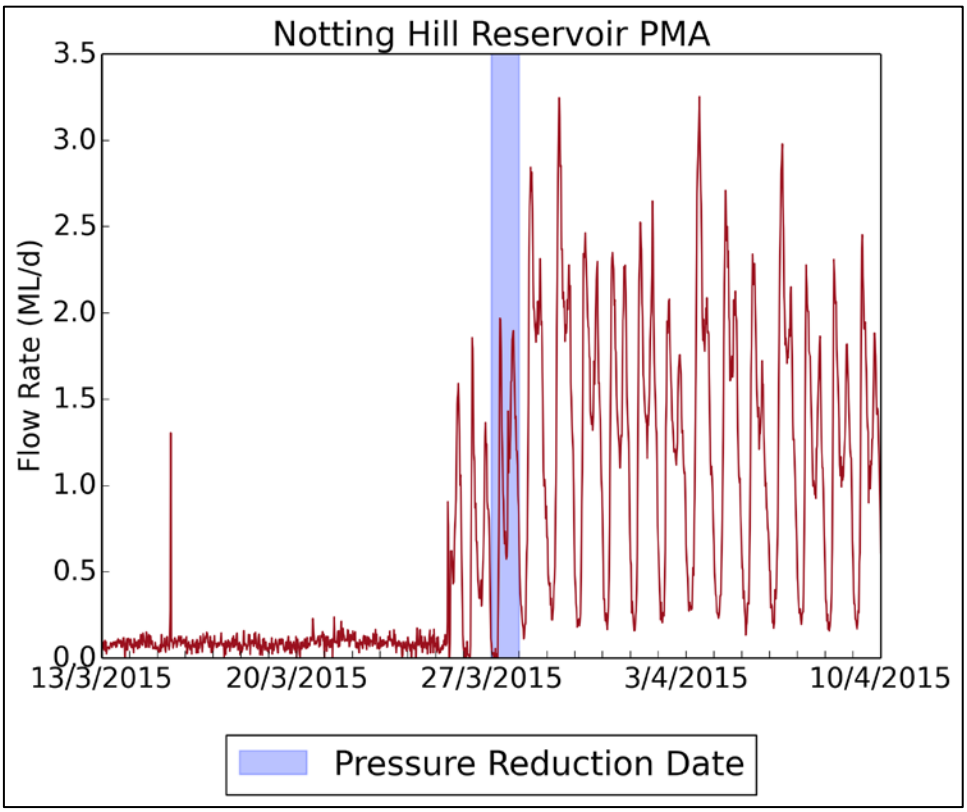

Figure 2: Notting Hill, time series of water consumption in the zone for 2 weeks either side of the intervention date.

5.2 Hallam North PMA

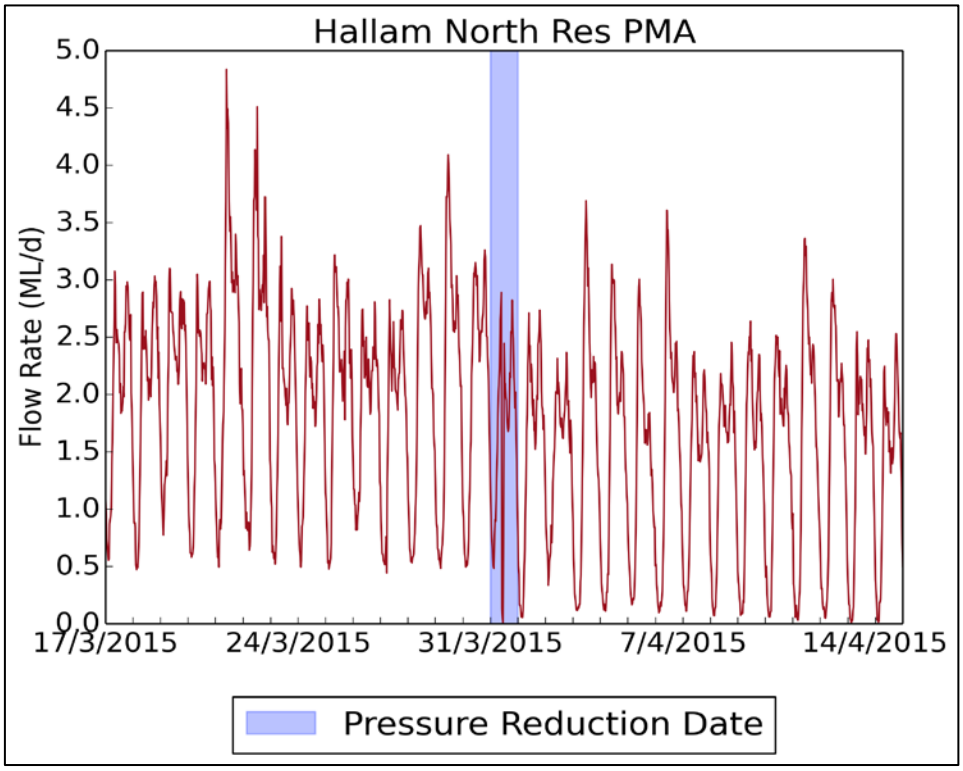

Figure 3: Hallam North, time series of water consumption in the zone for 2 weeks either side of the intervention date.

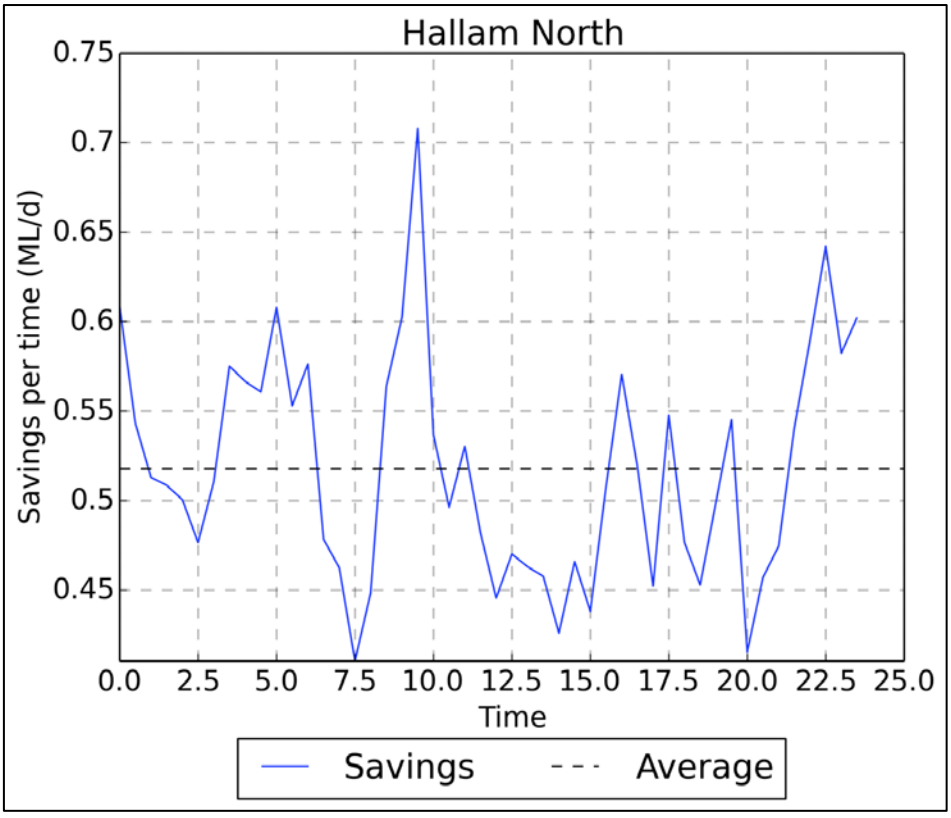

Figure 4: Hallam North, difference between ISF 1 predicted and actual, shown by time.

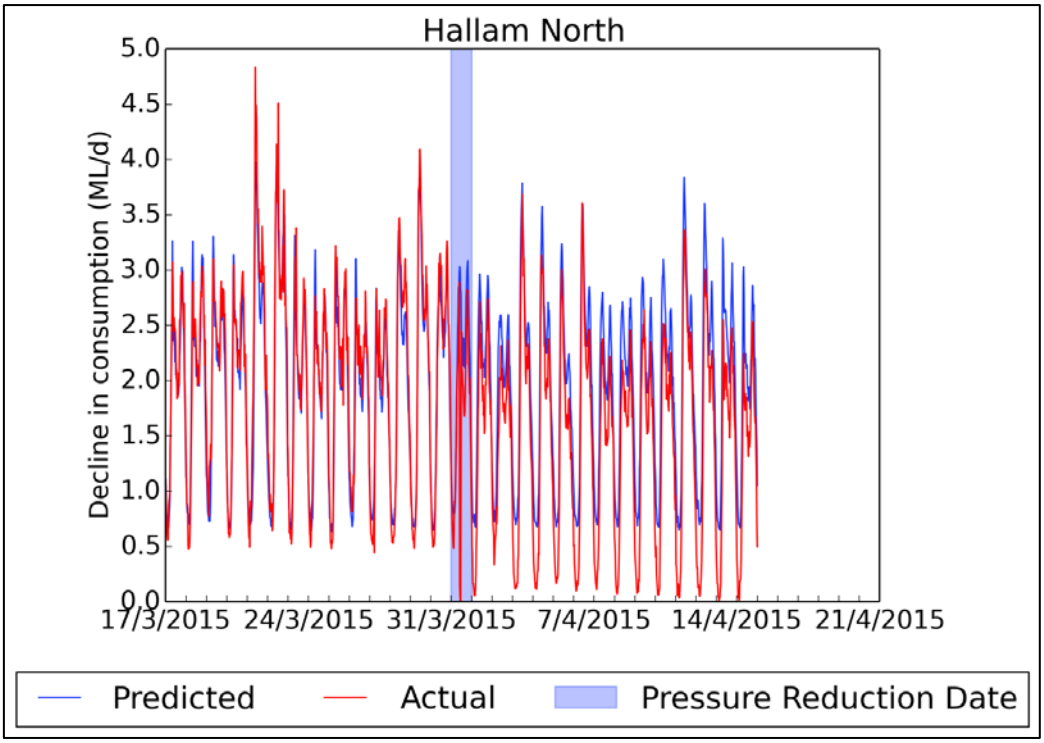

Figure 5: Actual flow of Hallam North compared to the predicted estimate from ISF 1.

Zone	ISF 1 Predicted – Actual (ML/d)	Estimated annual saving (Ml/year)
Hallam North	0.518 ± 0.021	**189**

5.3 Montrose Boronia PMA

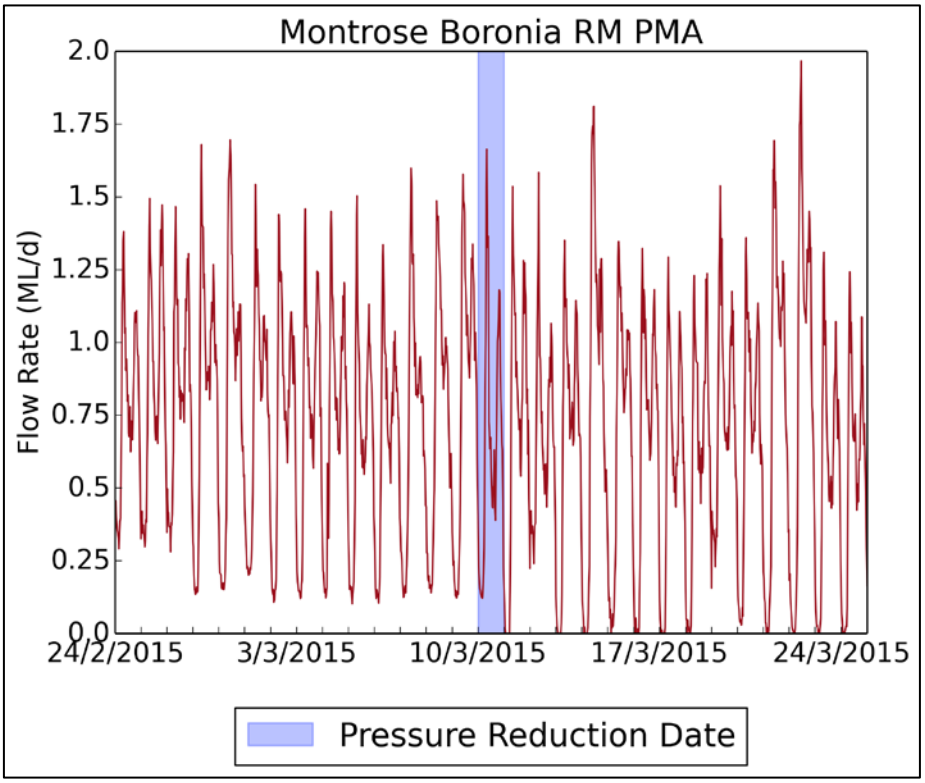

Figure 6: Montrose Boronia, time series of water consumption in the zone for 2 weeks either side of the intervention date.

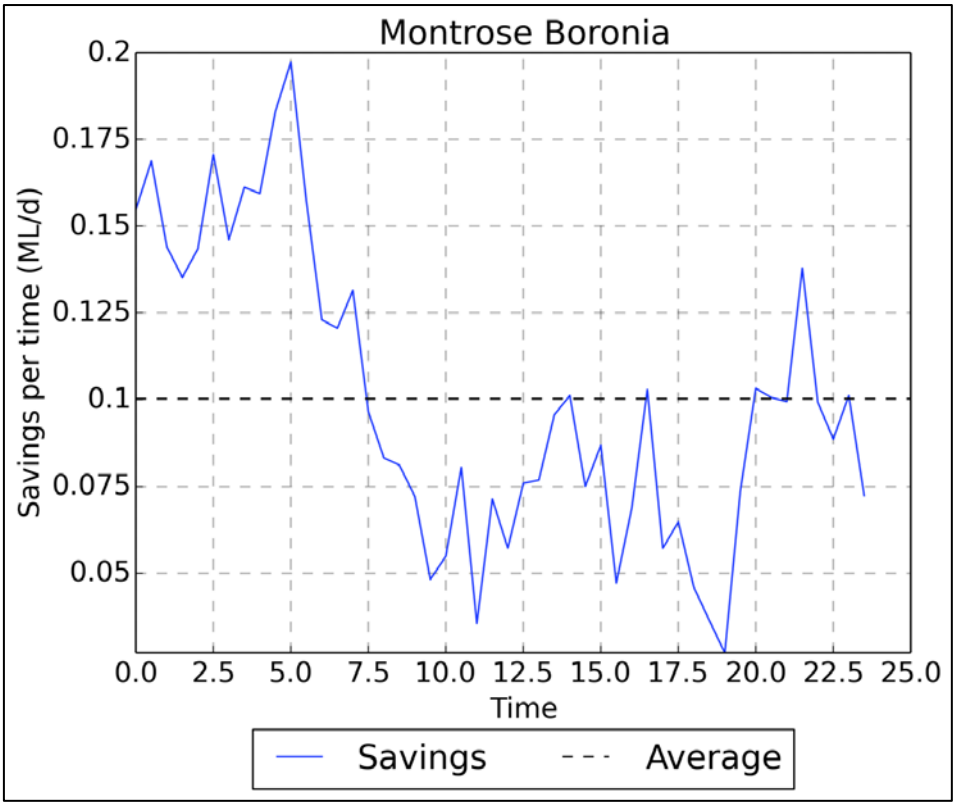

Figure 7: Montrose Boronia, difference between ISF 1 predicted and actual, shown by time.

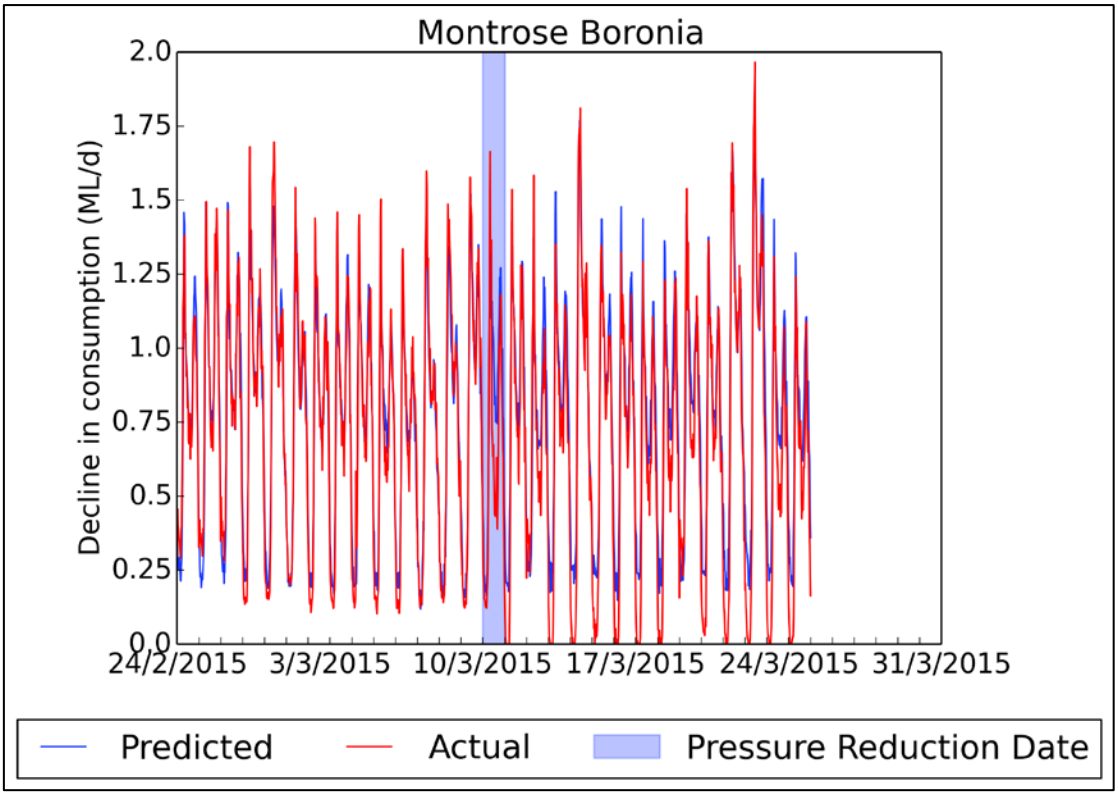

Figure 8: Actual flow of Montrose Boronia compared to the predicted estimate from ISF 1.

Zone	ISF 1 Predicted – Actual (ML/d)	Estimated annual saving (Ml/year)
Montrose Boronia	0.100 ± 0.011	**37**

5.4 Mt View Reservoir PMA

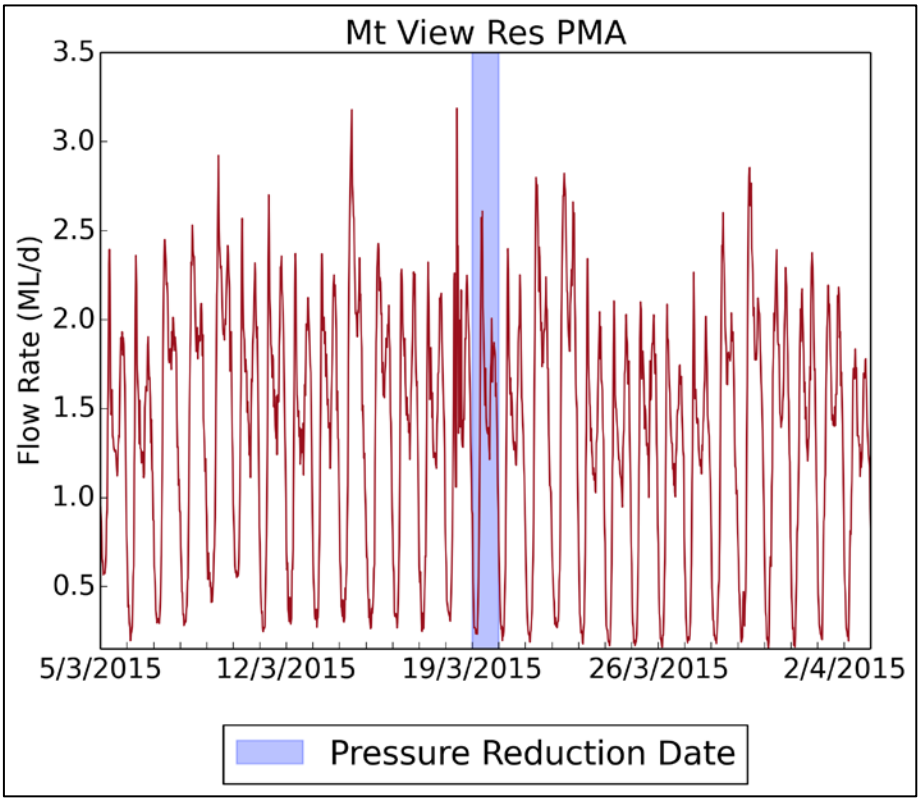

Figure 9: Mt View, time series of water consumption in the zone for 2 weeks either side of the intervention date.

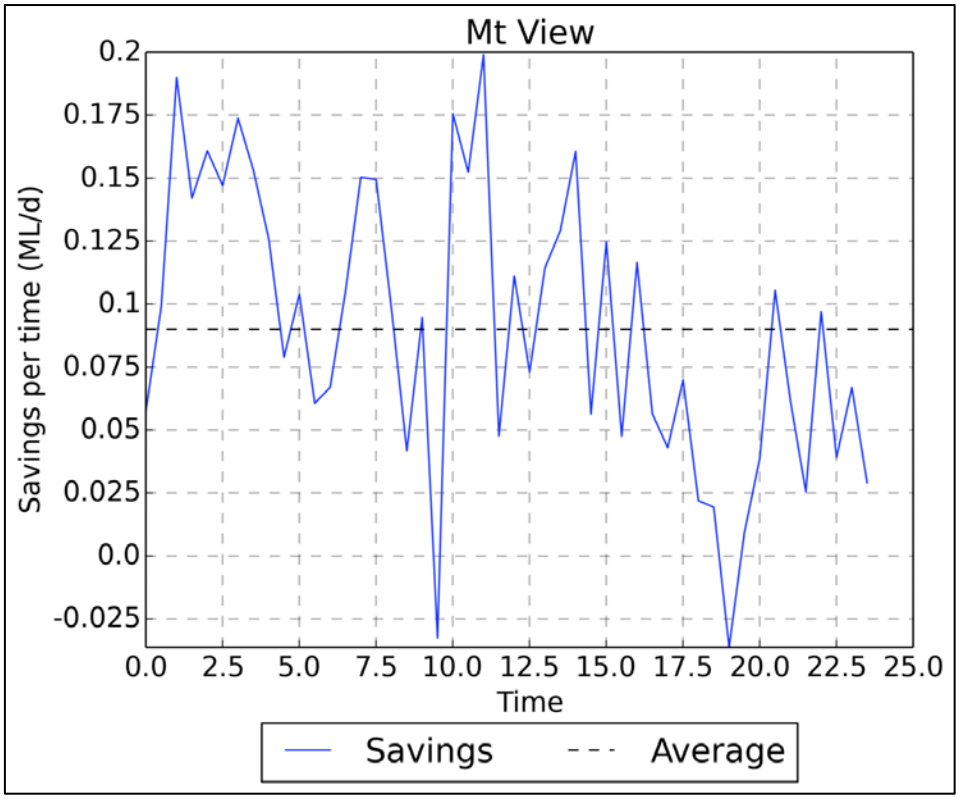

Figure 10: Mt View, difference between ISF 1 predicted and actual, shown by time.

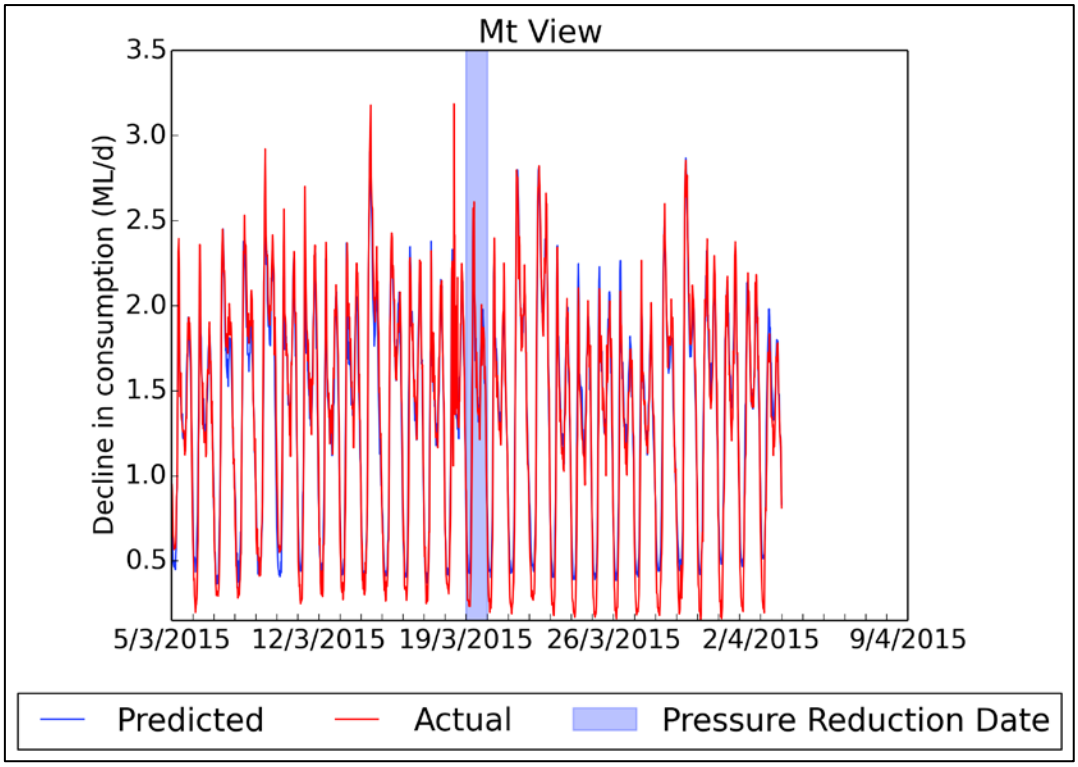

Figure 11: Actual flow of Mt View compared to the predicted estimate from ISF 1.

Zone	ISF 1 Predicted – Actual (ML/d)	Estimated annual saving (Ml/year)
Mt View Reservoir	0.090 ± 0.017	**33**