# Consequences of Intermittent Supply on Water Distribution Networks

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# BACK to BASICS for a more SECURE FUTURE

An NRW Management Workshop

15th to 16th February 2018

Tsogo Sun Elangeni Hotel, Durban

Session 5.1: Intermittent Water Supply Consequences

Allan Lambert, Mark Shepherd

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# Intermittent Supply Experiences: Allan Lambert

- Jordan 1995-97
- Brazil 1997-2002
- Bosnia-Herzegovina 1997
- Saudi Arabia 1998
- Cyprus 2008-9
- Mexico 2016-18
- LEAKSSuite Library

# Jordan: World Bank, 1995-7

- Large city, intermittent pumped supplies, properties with roof tanks
- Surprised to find that mains burst frequencies were many (30?) times the rate for similar pressure in a continuous supply system (UK)
- This did not seem to be considered unusual by the Jordanian Utility
  - but in 1995, almost no published international work on pressure: burst frequency relationships existed
- This made me think that probably most Utilities come to believe:
  - that their repair frequencies (whatever they happen to be) are ‘normal’
  - and can only be dealt with by replacing infrastructure
- Utilities did not seem to consider that their system design or management might be the cause or partial cause of the high burst frequencies

# Brazil

- Brazil: São Paulo 1997-2004
  - intermittent supply, properties with roof tanks, supplied >95% of time
  - resulted in rota cuts (rodizio) over regional systems to share restrictions
  - very high burst frequencies on mains and services, intensive leak detection
- Julian Thornton recommended move to pressure management would reduce leak flow rates sufficiently to achieve continuous supply
  - Gpress software predicted benefits were achieved in 10 pilot areas
  - around 1200 PRVs were installed over 4 years, 24/7 supply achieved
  - Targeted service connection replacement also greatly reduced leakage
  - SABESP became expert in managing system pressures to manage leakage
    - and during the 3 year 2013-15 drought, rodizio was avoided by extreme pressure management at critical points without completely shutting off supplies

# Sarajevo, 1997

- Project to restore supplies in Sarajevo soon after the end of the wars in the Western Balkans
- The city had been heavily shelled, and was being supplied by intermittent pumping to properties without any storage after the Zone reservoir
- With no pressure transient control, and frequent valve operations, leak detection contracts found large backlog of leaks which were being repaired
  - but transients caused further frequent repeat leaks and no progress was being made
- Leak detection and repair ineffective without pressure management
- The leakage target was set only in % of terms, which was illogical as any leakage saved would be used to pressurise the system for longer
- the primary target for intermittent supply should be to achieve 24/7 supply, even if it means operating at lower pressure than normal

# Saudi Arabia, 1998

- Large city, intermittent supplies, properties with ground tanks
- Properties supplied for around 2 days in 7 (approximately)
- Utility proud of low % NRW (around 4% of SIV from memory)
  - due to long periods without pressurised water mains!
  - but ILI performance (when system pressurised) was Class D (ILI > 8)
- Active leakage control was extremely labour intensive
  - Utility could only search for leaks when the mains are pressurised
  - So small sections of system (2 streets at a time) were pressurised with water from small tanks on vehicles, to permit checks for leaks

# Lemesos, Cyprus, 2002-12

- Utility with roof storage tanks in properties
- From 2002 to 2007, real losses were reduced from 138 to 92 lit/conn/day, and ILI from 2.7 to 2.0, with continuous supply – an excellent performance
  - using IWA approach with pressure-managed small single entry point DMAs
  - AZNP reduced by 32% from 52.5 to 35.8 metres
  - reported bursts reduced by 45% on mains and 40% on service connections
- But in 2008/09 drought, all of Cyprus had to operate intermittent supply
  - mains breaks trebled, service connection breaks doubled during period of IS
  - minimum night flow increased by more than annual volume of water saved
  - unable to get back to pre-drought leakage levels even 3 years after the event
- This Case Study documenting the problems and consequences of IWS is freely available at https://www.leakssuitelibrary.com/wp-content/uploads/2019/08/Bambos-EU-Ref-Doc-Case-Study-update.pdf

# Mexico, 2016-18

- Large city, intermittent supplies, properties with roof tanks
- Properties supplied for around 70% of time, average pressure < 30m
- High burst frequencies for mains, and very high for services
- Utility proposed DMAs and leak detection to reduce leakage
- Following Dec 2016 Masterclass, decided to use pressure managed zones as foundation strategy to achieve continuous 24/7 supply
- New techniques developed for tracking leakage from AZP pressures
- Implementation started: steady progress to date, a work in progress
- See https://www.leakssuitelibrary.com/wp-content/uploads/2019/08/Monterde-Saltillo.pdf

# Masterclass on IWS with international experts, UK, Nov 2016

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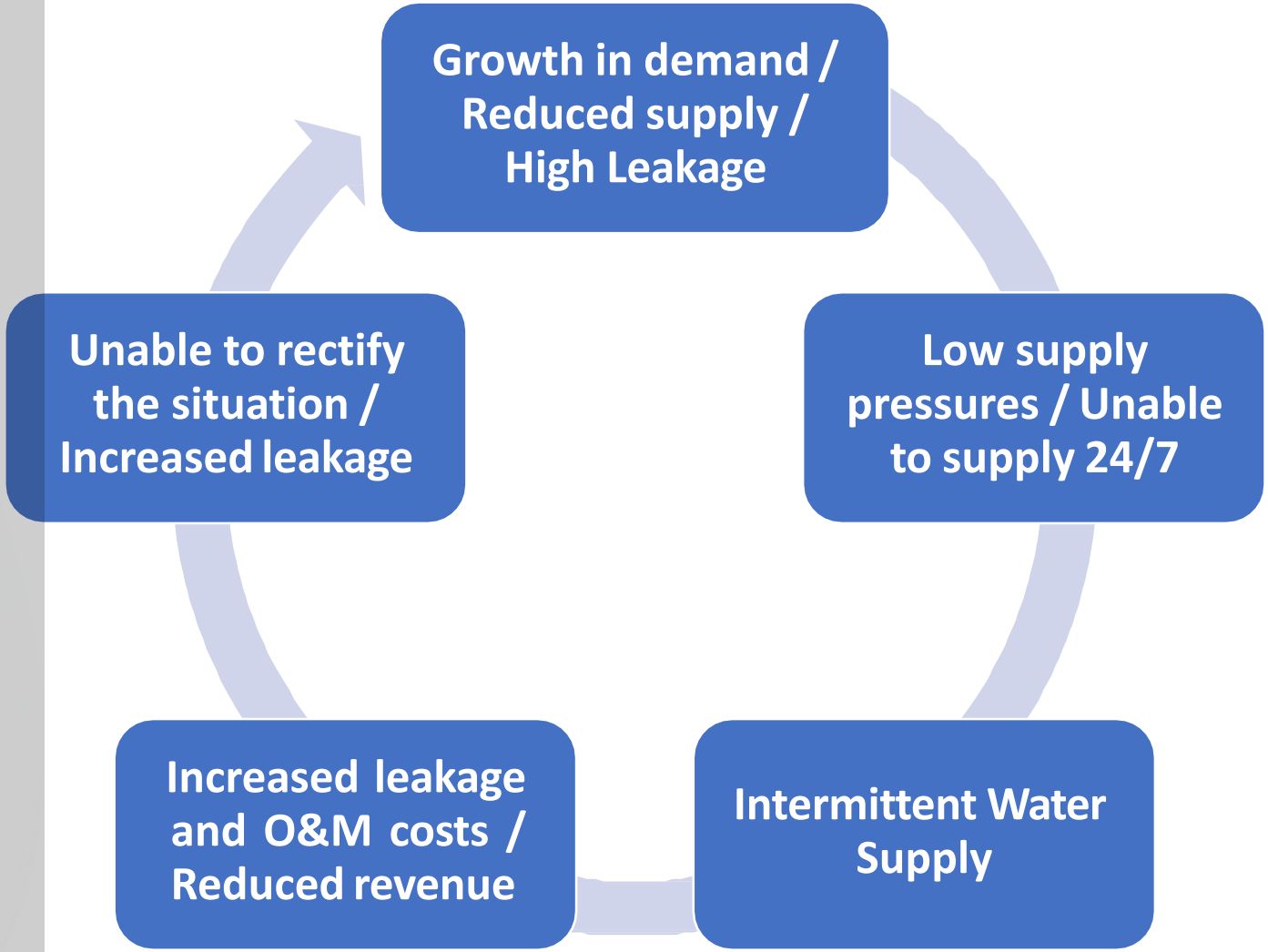
# IWA Specialist Group on IWS

- Up to end of 2017, IWS was a topic included in the IWA Water Loss Specialist Group
- In February 2017, it's importance as a key topic was recognised by setting up a separate IWA IWS Specialist Group
- IWS Specialist Group is chaired by Bambos Charalambous (Cyprus)
  - Sessions on IWS at the IWA Water Efficient Conference, Bath, July 2017
  - 1st IWA IWS Conference in Kampala, Uganda in April 2019
- LEAKSSuite Library recommends all those with an interest in IWS to contact the IWA IWS Specialist Group, htolba1@outlook.com

# The vicious cycle of iws: Source: Charalambous



# What have I learnt about Intermittent Supply?

- Severe consequences when 24/7 supply system adopts intermittent supply
  - Multiple pressure transients from valving operations and system recharge
- Very damaging to distribution system infrastructure
  - mains and services repair frequencies both increase significantly
- Intermittent Supply influences ability to carry out leak detection
  - Visible leaks cease to run, no noise from unreported leaks
  - Minimum night flows increase, volume savings less than simple calculation suggests
- Medium term effects (Lemesos paper)
  - Higher leakage from damaged infrastructure for several years afterwards
  - Significant additional leak detection costs
- Absence of pressure management means no control during recovery
- 1st objective: to get back to 24/7 supply, at lower pressure if necessary
  - plus pressure management and service pipe replacements to regain control

# LEAKSSuite Library Intermittent Water Supply

- Dec 2016 Masterclass: Managing NRW : Roof Storage Tanks & Intermittent Supply
- Attendees supported setting up a LEAKSSuite Info-hub on IWS and contributed the papers and presentations below
- These are now located at https://www.leakssuitelibrary.com/intermittent-water-supply-iws/

| Source | References |
|---|---|
| Monterde, N | Challenges in moving to 24/7 water supply in Aguas de Saltillo City, Mexico |
| Charalambous B | INTERMITTENT WATER SUPPLY: Ten Reasons why it should be Avoided |
| Peña M, Bazet J.I, Poona V.A. | Pressure Management and System Stabilisation: Case Study in eSikhaleni, South Africa |
| Charalambous B, | The Effect of Intermittent Supply on Water Distribution Networks |
| Charalambous B, Liemberger R, | Dealing with the complex Interrelation of Intermittent Supply and Water Losses. Paper and Presentation at IWA World Congress, Brisbane, Australia, October 2016 |

# Intermittent Supply Experiences: Mark Shepherd

- Recent drought in South Africa
- Durban
- iLembe

# Is Our Drought Affecting Us?

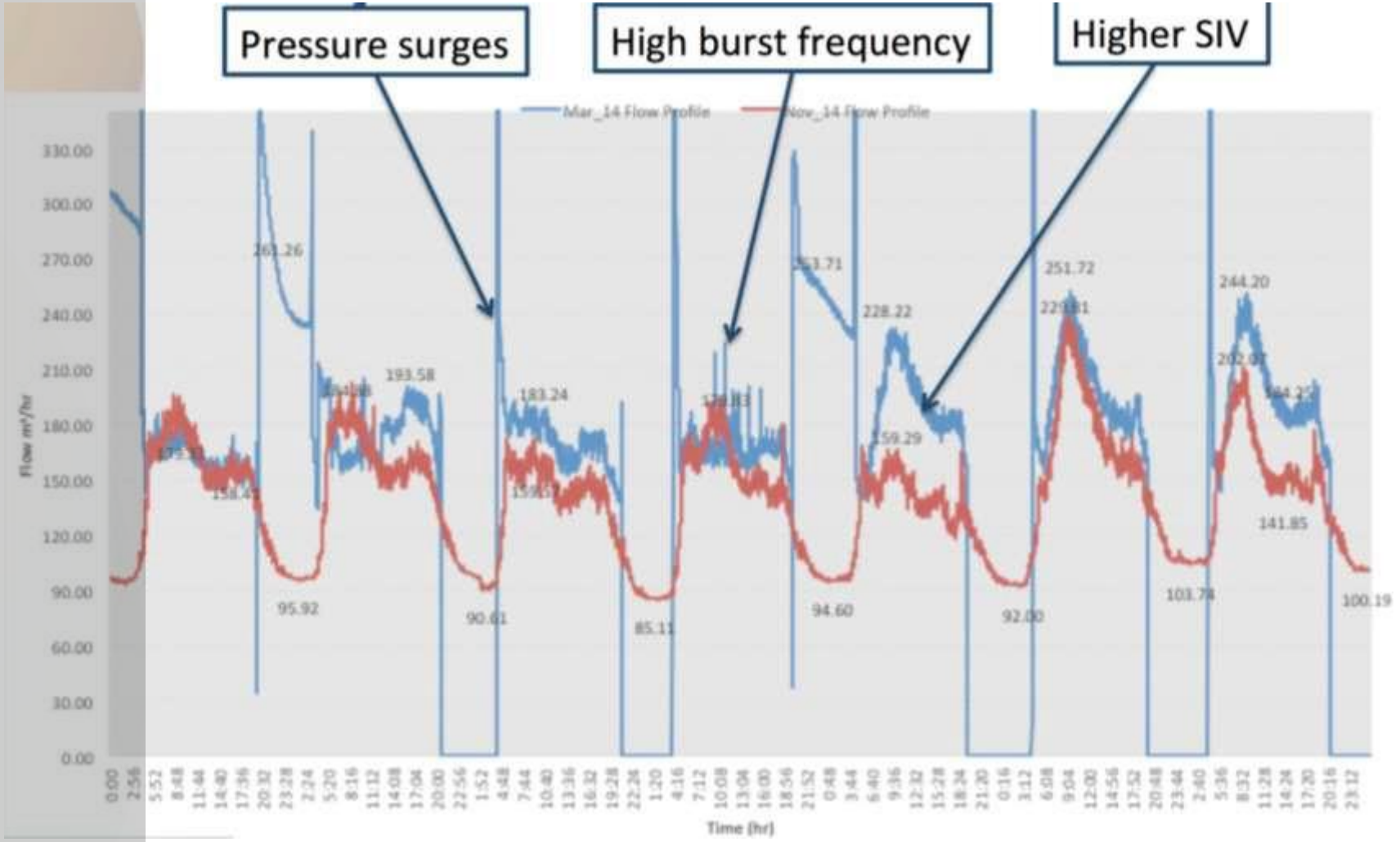



# Technical Impacts of Drought

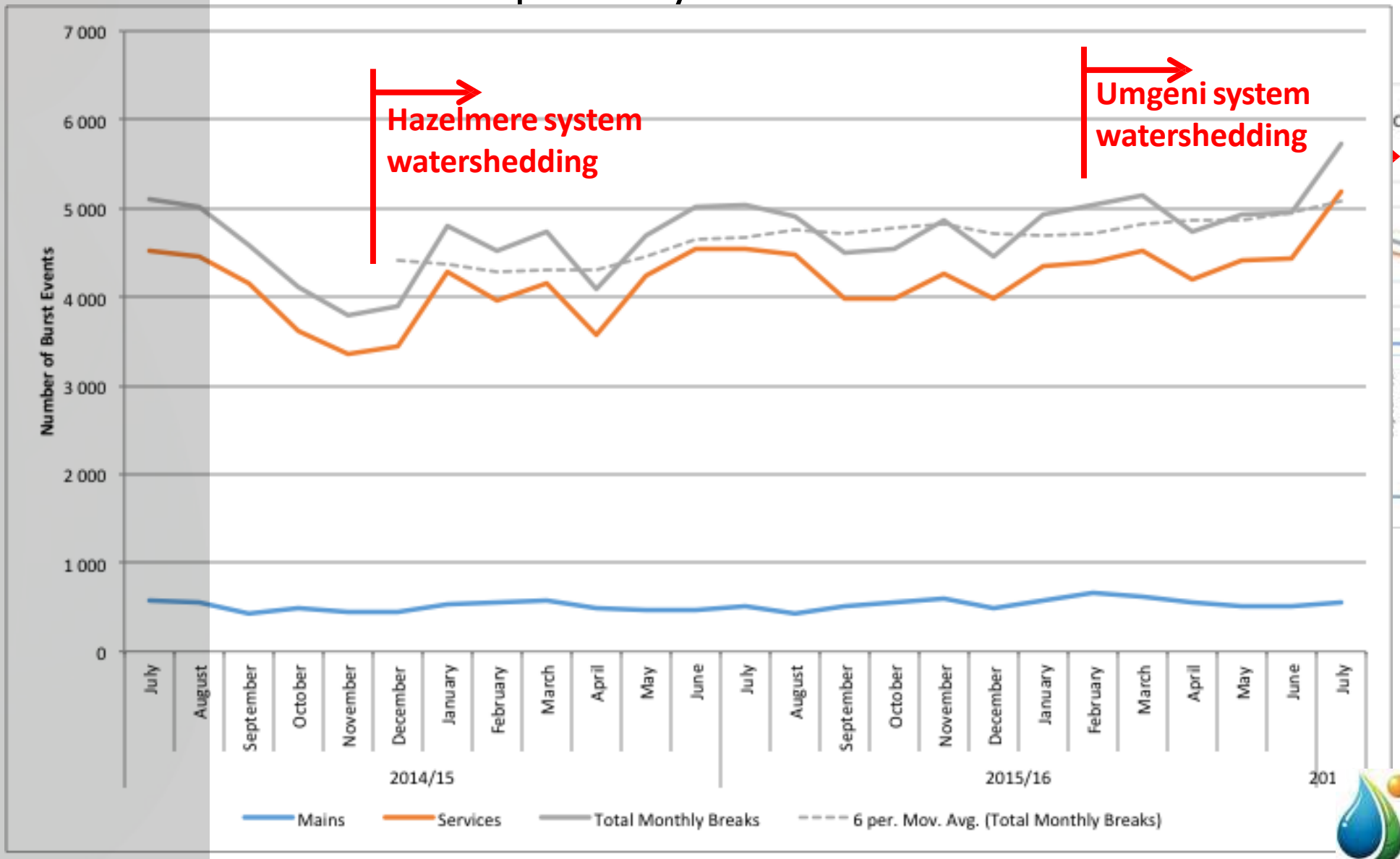
Technical impacts of drought are ways that water infrastructure is affected :

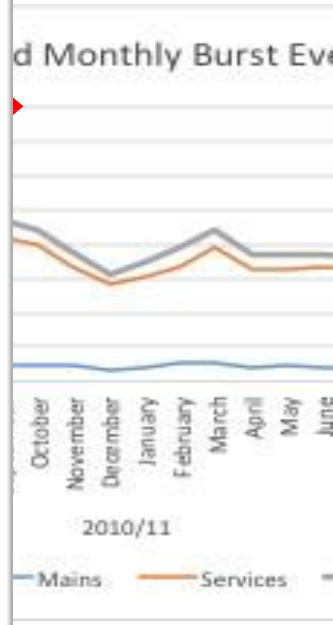
- Intermittent water supply – positive and negative pressures, increased bursts
- Negative impacts on water quality
- Inefficient system operation
- Damage to pumps, motors and control valves
- Non-operational PRV’s
- Damage to consumer meters
- Increased vandalism and abuse
- Increased billing to consumers – increased customer complaints, increased credits

# Impact of Intermittent Water Supply: eThekwini



# Impact of Intermittent Water Supply on Burst Frequency: eThekwini



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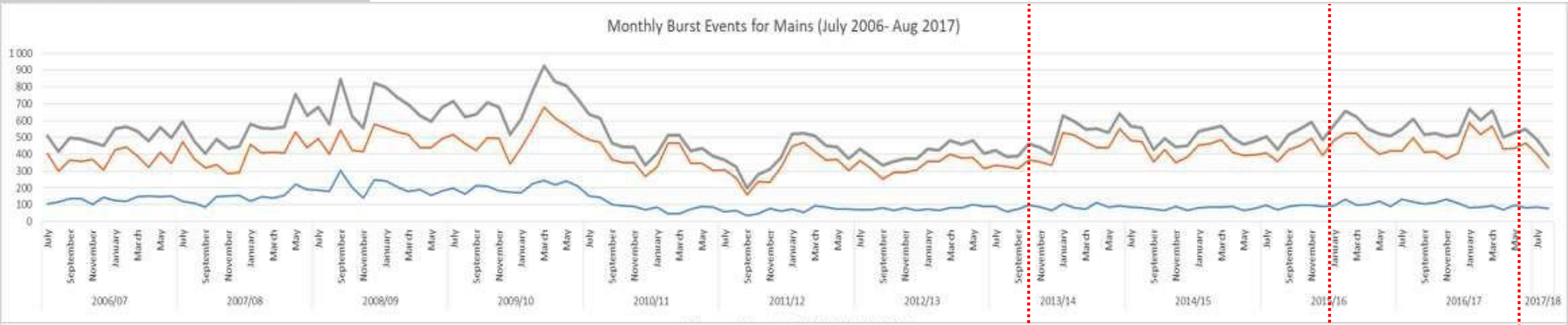


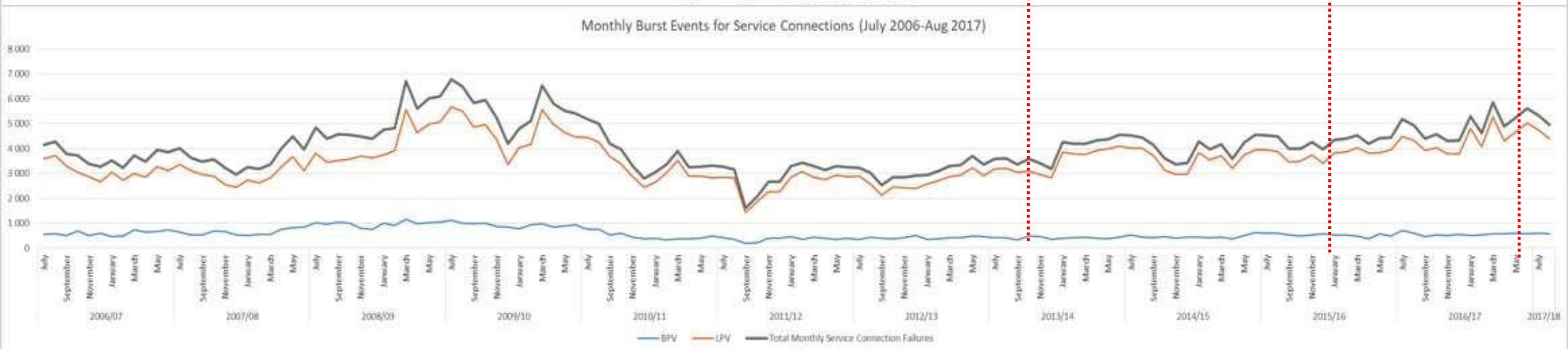

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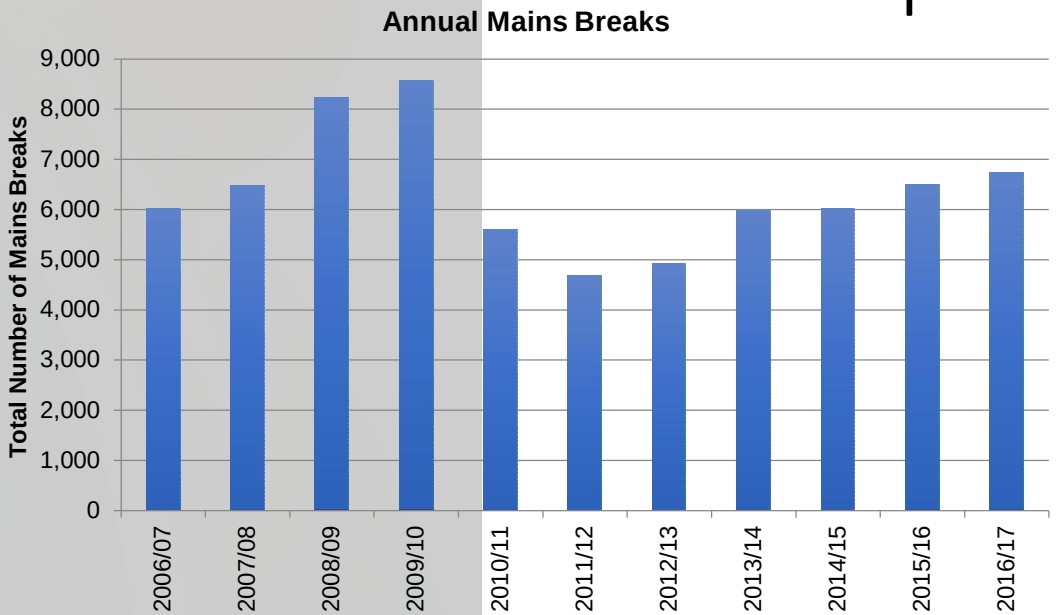
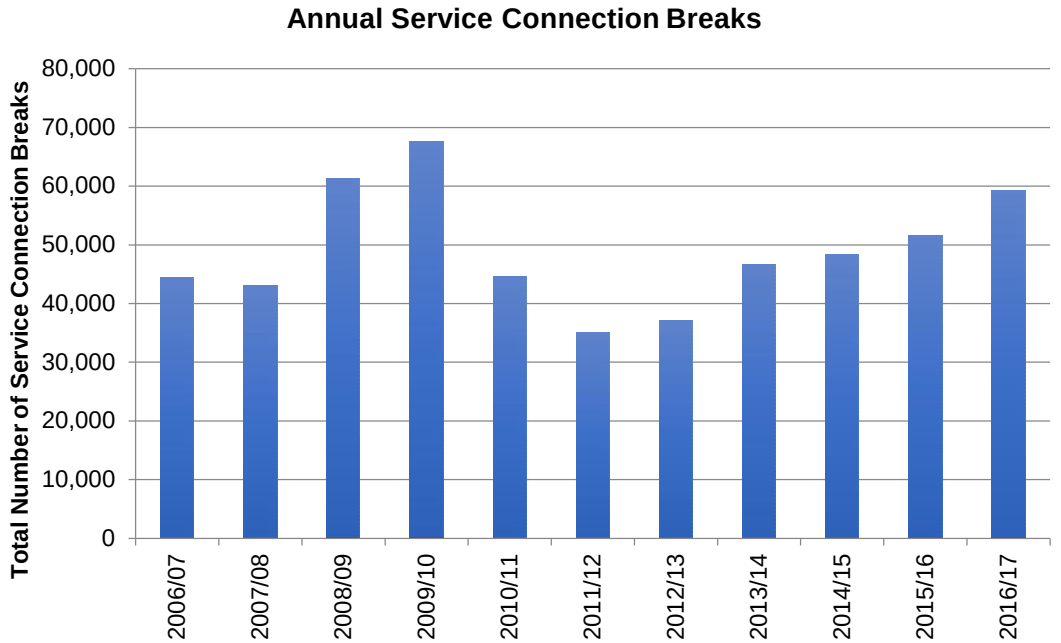
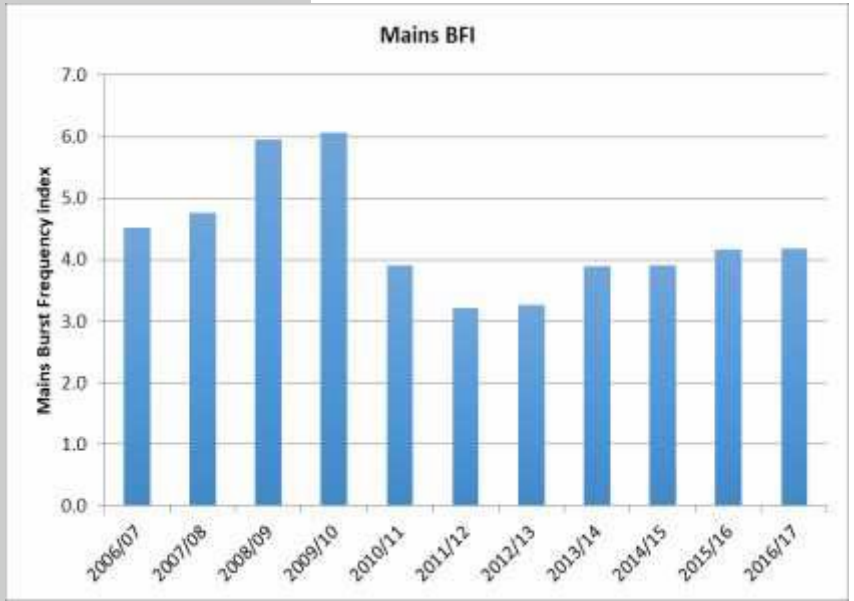
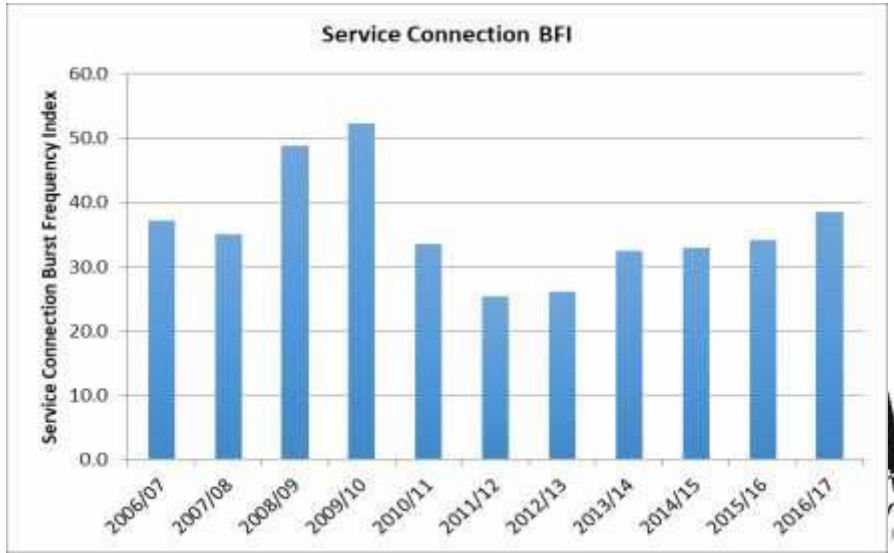
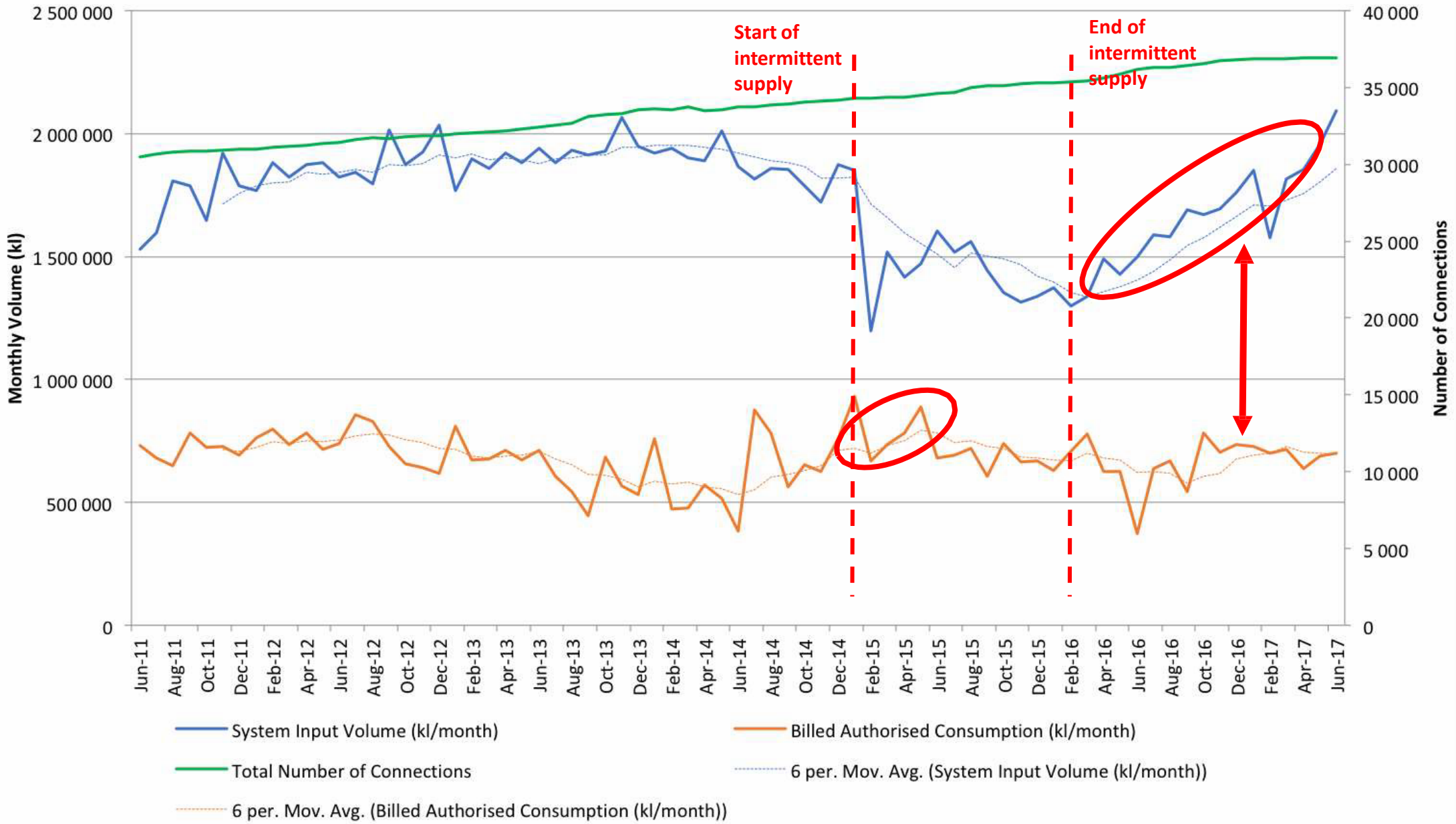


# iLembe District Municipality
## Monthly Volumes and Connections July 2011 to June 2017



# Lessons Learned from Intermittent Water Supply

- Pressure management offers opportunities to avoid intermittent supply by reduction of excess pressures, leak flow rates, bursts on mains and services, and some components of consumption
- Burst frequency will increase as a result of moving onto intermittent water supply. In our experience, service connection bursts have increased more than mains bursts
- Intermittent water supply – recovery plans to full pressurized supply are just as important as plans going onto intermittent supply in the first place
- The need for sufficient, functioning air valves in reticulation network cannot be overstated – this will protect infrastructure, including consumer meters, from both negative and positive pressures
- Damage to consumer meters is a reality, which will affect billing. Meter maintenance/replacement programs need to be implemented once full pressure supply has been restored

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