Software Tools to Help Reduce Leakage in Water Distribution Systems

The previous issue of Water Wheel reported on the significant reduction in water leakage from distribution systems that is possible through pressure reduction at night. Readers were promised abridged information on four water demand management (WDM) models available to South African local authorities, on which municipal leaders and financial and water supply managers will be briefed at a short course to be offered in five centres around the country in November. The following descriptions of these models are abridged from a Water Research Commission (WRC) brochure on the tools, (including software) available to promote water demand management in South Africa[1].

Although comprehensive and sophisticated WDM software is available internationally and locally, it may be beyond the financial reach of smaller municipalities. The WRC thus focused on providing free software solutions to assist water suppliers in understanding and managing their non-revenue water. Four packages were developed for the WRC by WRP (Pty) Ltd based on the UK-developed Burst and Background Estimate (BABE) methodology. The software was customised for South African conditions, made more user-friendly where necessary, and is available free of charge to domestic water suppliers.

[1] Brochure produced by RS McKenzie of Water Resource Planning and Conservation (WRP) (Pty) Ltd and JN Bhagwan of the WRC.

THE WRC'S FOUR BABE-BASED MODELS

Model and details	ISBN No	WRC No
SANFLOW Model designed to provide an indication of the unexplained burst leakage in a zone from the analysis of the minimum night flow.	1 86845 490 8	TT 109/99
PRESMAC Model designed to estimate the potential for Pressure Management in a pressure zone based on logged flow and pressures over a representative 24-hour period.	1 86845 772 2	TT 152/01
BENCHLEAK Model designed to establish the levels of non-revenue water in a water utility or zone metered area, based on the latest IWA recommendations regarding the Minimum Level of Leakage.	1 86845 773 7	TT 159/01
ECONOLEAK Model to evaluate the most appropriate frequency for undertaking Active Leakage Control	1 86845 832 6	TT 169/02

The rationale for the development of the various models is as follows:

ECONOLEAK

The purpose of ECONOLEAK is to assist water suppliers in understanding the economics of active leakage control and the economic level of leakage. Most water distribution managers and engineers are aware that they can achieve significant savings through reduced leakage. But it is often difficult to convince financial managers to allocate the required funding for specific leakage-reduction activities even when it is well known that the costs will be recovered in less than a year.

Reduction of leakage in a water distribution system can be achieved by various measures including retro-fitting, metering, pressure management, active leakage control and mains replacement. The major problem facing water distribution managers is to determine which measures are the most beneficial and how much can be saved in real terms from each measure.

It is thus important to analyse the leakage properly and to identify and quantify the major problem areas. After the problems have been identified and quantified, the most appropriate leakage reduction measures can be determined and accompanied by sound financial motivation.

The ECONOLEAK model is not designed to address the economic issues associated with all of the various types of leakage-reduction activities mentioned above. ***Instead, it is aimed specifically at determining when a water supplier should invest in active leakage control for a specific zone metered area.*** The model complements the SANFLOW, PRESMAC and BENCHLEAK models which together provide water suppliers with key tools to assist them with their leakage management.

In order to use the ECONOLEAK model, the user must supply considerable factual system data on the frequency of burst pipes and the costs of repair. Such information is often difficult to obtain and in many cases the water supplier is unable to provide even the most basic leakage data. ***While this is clearly a problem in the short term, it does create an awareness of what information is required to undertake an economic analysis of leakage control.*** This in turn, should encourage water suppliers to start capturing and processing the necessary data so that they may be able to carry out some form of economic analysis in future. The model is very useful in creating awareness of ***the key information that all water suppliers should be capturing and monitoring on a continuous basis***.

SANFLOW

Measurement of minimum night-flow into a zone-metered area is possibly one of the simplest and most valuable actions that a water supplier can take in order to identify whether or not it has a serious leakage problem. The purpose of the SANFLOW Night Flow Analysis Model is to provide a standardised approach to evaluating burst and background losses in water distribution systems in South Africa.

The South African model stems from one of the UK-developed Burst and Background Estimate (BABE) techniques, with key improvements. It is extremely simple to use and all of the detailed calculations are hidden from the main screen. The main screen therefore provides a clear and concise overview of the leakage in a particular zone. Details of any of the calculated values can however be viewed by simply selecting one of a number of variables.

In summary, the SANFLOW model starts at the point where the UK basic research left off in 1996 and has taken the development to a new level of presentation and reliability. Through this model, the WRC hopes to encourage water suppliers to make use of a standard package for the assessment and interpretation of night-flow data as the basis for reducing unaccounted-for water.

PRESMAC

In the continual battle to reduce leakage from potable water distribution systems, the influence of pressure is often overlooked. The purpose of PRESMAC is to serve as a pressure management model for South African water suppliers.

Since distribution systems are designed to supply the minimum level of pressure during peak demand periods, it is clear that the pressure will increase during the periods of low demand. The pressures in potable water distribution systems are therefore significantly higher than required much of the time, particularly at night when demand is low. Since losses and leakage from a system are highly dependant upon pressure, it is also clear that leakage rates will be highest during the periods when few consumers are using water.

By using pressure reducing valves (PRV) according to time (time-modulation) or demand (flow-modulation), it is possible to reduce the pressure during periods of low demand and thus reduce leakage without adversely affecting the level of service to consumers. Software and hardware solutions can be used together to tackle pressure in potable water distribution systems.

Time modulated control offers the simplest form of Advanced Pressure Control and also the least expensive. It has certain limitations, however, one of which concerns the influence on fire fighting flows. If fire fighting flows present a problem, the time-modulated option may not be suitable, in which case the more advanced flow-modulated control, which provides greater flexibility and control, may be required.

The flow-modulated controller controls the pressure at the inlet point in accordance with the demand being placed on the system. During low demand periods the pressure is reduced to minimise excess pressure and the associated leakage.

The Water Research Commission initiated a project in 1999 to develop a South African pressure management model (PRESMAC) based on the BABE principles but modified to suit South African conditions where necessary.
It was clear from the eight pilot studies undertaken that pressure management was an effective tool for water demand management – in certain cases, by far the most effective form of leakage control that can be undertaken. If implemented properly it can provide very significant and cost effective savings which are both immediate and sustainable.

The PRESMAC pressure management model is used to assess the likely savings (in monetary terms) of various pressure reduction options (fixed outlet and time-modulated PRV's) in a selected zone metered area. The analysis is undertaken in a relatively simple and pragmatic manner and allows the user of the program to gauge the potential for pressure management very quickly and effectively without requiring a full detailed pipe network analysis.

Although the methodology is based on a number of simplifications and assumptions, in practice the predicted savings are generally within 10% to 20% of those achieved in practice.

It was this system, applied to Khayelitsha in the Western Cape as reported in the previous issue of *Water Wheel*, that paid for its installation costs in the first month of operation.

BENCHLEAK

The purpose of the BENCHLEAK model is to benchmark leakage in water distribution systems in South Africa.

Figures for 'Unaccounted-for Water' are often expressed as a simple percentage of system input volume. Such figures tend to be accepted blindly as a meaningful indicator of performance. Over the past decade, however, it has been recognised that percentages are often unsuitable and can be very misleading when used to assess the operational efficiency of management of real losses in distribution systems.

The problem to be overcome was that of how to express real losses in such terms that the leakage in one system could be meaningfully compared to the leakage in other systems. The WRC commissioned a study to develop a benchmarking system to enable the leakage rates in the many water supply systems throughout South Africa to be defined, calculated and compared in a standard and more meaningful manner.

The success or failure of the proposed methodology obviously depends on how diligently water suppliers complete the various forms and obtain the required information. A key objective of the BENCHLEAK software is to ensure that the information requested is relatively simple to provide. At the same time, the results and details provided from the software should be of use to water suppliers by detailing their water balances in a simple and pragmatic manner.

The potential problems of 'too much detail', or 'not enough detail' were tackled by developing colour-coded software – BENCHLEAK, which provides all the optional details that are likely to be required. Most of the items in the software are calculated fields with the result that the user need only provide some very basic information that should be readily available from its information system, or can be determined with minimal effort.

The BENCHLEAK software is designed in such a manner that it can easily be condensed into a single worksheet for all data entry once the water supplier is accustomed to the data requirements and use of the software.

It should be noted that while percentage values are not recommended for comparing leakage rates from one system to another, they are useful for comparing the leakage rates for the same system from one year to another. They can be used for 'internal benchmarking', but should not be used for 'external benchmarking'.

The Water Research Commission commissioned the development of the above models to assist local authorities in their drive to improve the efficiency of their water distribution systems. This is in line with the Government's imperative to make best use of this essential but increasingly scarce commodity and avert a serious water crisis in coming decades.