SOME RECENT DEVELOPMENTS IN WATER DEMAND MANAGEMENT IN SOUTH AFRICA

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SYNOPSIS

Within the last few years there has been a growing realisation that the rapidly increasing water demands throughout South Africa are not sustainable and that if the growth in demand is not curbed, the country will face a serious water crisis early in the next century. As a result this realisation, there has been a significant change of emphasis away from the development of new water transfer schemes to a country wide campaign of water conservation. The aims of the new initiatives are to curb the growth in water demand through education and more efficient use of the available resources. Several recent studies have shown that major proposed augmentation schemes can be postponed by many years if the growth in demand can be trimmed by only a few percent – a target that is certainly achievable. The savings associated with delaying a new water transfer scheme are so large that the measures needed to achieve the delay are not only environmentally attractive but also very cost effective.

New legislation being drafted by the government will provide the first real incentives for better water use efficiency (or penalties for inefficient use) and this will result in stricter control of Unaccounted-For Water. Much of the new legislation is based on overseas experience and in particular the Burst and Background Loss concepts which were developed in the UK and have since been applied successfully in many other parts of the world.

The paper presents details of some of the many initiatives that have been taken in South Africa regarding the control of Unaccounted For Water. Various research projects in the field of Unaccounted-For Water and Urban Demand Management have recently been supported by the SA Water Research Commission and some of these are discussed in the paper.

INTRODUCTION

With regards to water resources, South Africa is a land of many contrasts. It has relatively low rainfall which together with the high evaporation rates results in a very low unit runoff for the country. South Africa is rated as one of the twenty most water stressed countries in the world. It receives an average rainfall of 500 mm per annum (well below the world average of 860 mm per annum), which is unevenly distributed with at least 65% of the country receiving less than 500 mm rainfall. To compound the problem, most of the rainfall is concentrated along the narrow region on the southern and eastern coastline (DWAF, 1986).

As a result of the increasing demands for water in many parts of South Africa, the South African Department of Water Affairs and Forestry (DWAF) has created a very complex and integrated bulk water distribution network. This often involves major interbasin water transfers involving the transfer of water over distances of many hundreds of kilometers and pumping heads in excess of 500m. Large reservoirs are needed to store the water and associated transfer schemes are often needed to move the water from the source basins to the areas where it is most required. South Africa's bulk water infrastructure must rank as one of the most sophisticated in the world requiring equally sophisticated management techniques to ensure efficient use of the available resources. Such techniques have been developed by DWAF over a period of 17 years with the result that South Africa is now regarded as one of the world's leaders in water resource management.

IMPORTANCE OF WATER DEMAND MANAGEMENT IN SOUTH AFRICA

The requirement for water in South Africa has been growing at between 4% and 5% since the 1930's. If the demands for water continue to increase at this rate, many parts of the country will effectively enter a state of continuous water stress within the next 50 years. Obviously this cannot be allowed to happen.

Until recently, the general approach to water management in South Africa was to develop new water projects and transfer schemes in order to keep ahead of the ever increasing requirements due to the growing population and improved living standards. This type of supply management was justified to some extent by the relatively low financial costs of the initial schemes together with low interest rates and high inflation. In recent years, however, the situation has changed dramatically through both a greater awareness of environmental issues and very high real interest rates. Consequently, the emphasis has shifted from the purely supply orientated approach to one of both supply and demand management with the latter receiving priority.

Bold and meaningful measures have recently been taken by the South African Government through the new Water Services Act (Government Printers,1997)and the National Water Act (Government Printers,1998). They introduce a new approach to water management, one in which demand management, water use efficiency and integrated catchment management are integral to the entire planning of water resource management and development.

INITIATIVES BEING UNDERTAKEN BY THE WRC

In order to promote and encourage efficient use of the available water resources in South Africa, the Water Research Commission (WRC) has initiated and supported numerous projects. Although some very comprehensive and sophisticated software is already available both internationally and locally, it is often too expensive for many of the smaller municipalities who cannot afford to purchase such packages. The WRC has therefore concentrated on providing low cost software solutions to help water suppliers in managing their unaccounted-for water. The packages discussed in the remainder of this paper have either already been completed or will be completed during 2000. They can be obtained from the Water Research Commission (see web site at www.wrc.org.za) and are generally supplied without charge .

The following packages are now either available or will be available during 2000:

- Annual Water Balance Model(Water Auditing – 1999)
- Background Night Flow Analysis Model (1999)
- Economics of Leakage Model (2000)
- Pressure Management Model (2000)
- Benchmarking of Leakage Model (2000)

Annual Water Balance Model (and New Code of Practice)

In order to support the new National Water Supply Regulations, a Code of Practice (COP) to facilitate accounting for potable water within distribution systems and the corrective actions to reduce and control UAW has also been developed to help water suppliers manage their distribution systems. The COP was developed through the South African Bureau of Standards (SABS 0309, 1999) with input from various individuals who have an interest in the water supply. It was released to the public in August 1999 and can be obtained directly from the SABS.

It is interesting to note that the South African COP has adopted many of the general Burst and Background Estimate (BABE) principals developed for the UK water supply industry in the early 1990's (UK Water Industry, 1994). The adoption of the BABE principals now allows South Africa to use, and contribute to, the latest general practices adopted in various other parts of the world.

Annual Water Balance Model

The new Water Supply Regulations clearly state that each water supply utility in South Africa must provide an annual water balance to identify the level of unaccounted-for water in each supply area. In order to facilitate this process, the South African WRC supported the development of software that can be used by each water supplier to provide their annual water balance calculations. By providing a standard software package, it will encourage all water suppliers to adopt a standard approach and the results from each supplier will therefore be comparable.

The Annual Water Balance Model was completed in 1999 and is included as part of the new Code of Practice mentioned earlier (SABS 0306, 1999).

Background Night Flow Analysis Model (SANFLOW)
Measurement of minimum night-flow into a zone-metered area (ZMA) is possibly one of the simplest and most valuable actions that a water supplier can take in order to identify whether or not they have a serious leakage problem.

In most zones, the minimum night flow occurs sometime between midnight and 4 am. In order to evaluate the level of leakage in a particular zone, the minimum night-flow can be split into various components in accordance with the general BABE principals as shown in **Figure 1.** (WRC, 1999).

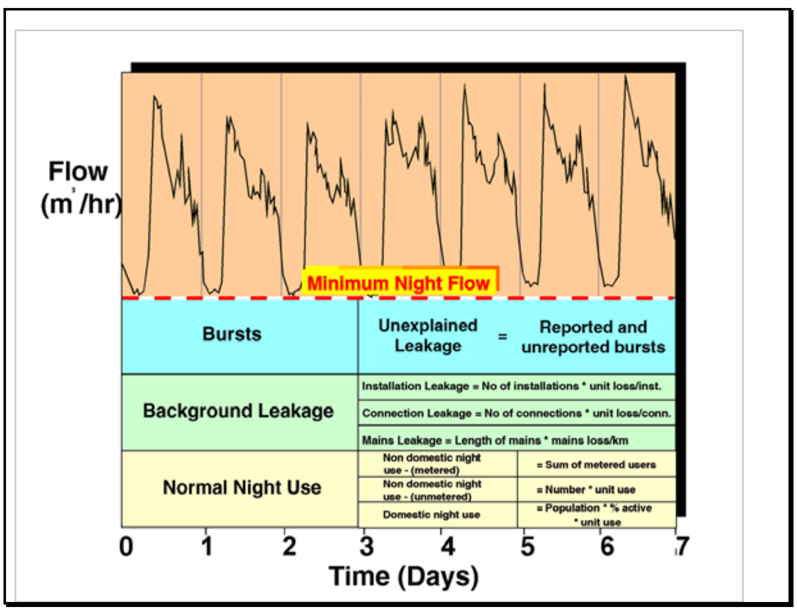

Figure 1: Components making up the minimum nightflow

The analysis of background night flows is a simple exercise and the new SANFLOW model provides a quick and effective aid to water suppliers in this regard. The program was designed specifically to assist water suppliers in identifying likely problem areas with respect to leakage and conversely also those areas that do not have a serious leakage problem. The development of the new model was initiated and supported by the South African Water Research Commission and was officially released in August 1999.

The model is based directly on the BABE principals as set out by the UK Water Industry (1994) and is available from the internet (www.wrc.org.za).

The SANFLOW Model includes several additional features which are not currently available on any of the overseas versions. In particular, it includes the ability to undertake sensitivity analyses based on basic risk management principals in order to provide a likely distribution for the number of bursts in a zone or district. This feature enables the user to set an upper and lower limit on each parameter used in the model. The selection of the parameter values has often been criticised as too subjective with the result that different users may obtain different results from the same initial data. By using the sensitivity analysis feature of the model, this potential problem can be addressed.

Economics of Leakage Model (ECONOLEAK)

The economics of leakage control is becoming a very important issue since most water supply utilities in South Africa are operating on limited budgets. The water suppliers are often unable to provide proper motivation to carry out expensive rehabilitation or leak detection programmes.

The new ECONOLEAK Model enables a water supplier to identify when it is necessary to intervene through active leakage control. In other words, the program will assist water suppliers in identifying when they should send a leak detection and repair crew into an area to find unreported bursts.

In order to use the model, the water supplier should gather the information indicated in **Table 1**. It should be noted, that if the information is not readily available from the water supplier's records, the default values can be used until more reliable information can be obtained.

The ECONOLEAK model was designed to compliment the Background Night Flow Model and utilises much of the same information. It is, however, a stand-alone program operating in the Windows environment and written in Delphi.

The model uses the basic information described in **Table 1** to provide the water supplier with an indication of when they should intervene in a particular zone and also how much funding should be allocated to leakage detection and repair per annum. This information will assist the maintenance and technical staff to motivate for the appropriate funding from the finance department.

Table 1: Basic information required to use the ECONOLEAK Model.

Description	Units	Default value
Number of service connections	Number	-
Length of transmission mains	Km	-
Length of distribution mains	Km	-
Average system pressure	M	-
Unavoidable connection losses at 50 m of pressure	Litres/connection/hr	1.25
Unavoidable mains losses at 50 m of pressure	Litres/km/hr	20
Leakage from service reservoirs	As % of volume per day	0.1
Leakage through mains burst	M^3/hr at 50m pressure	12.0
Leakage from connection pipe burst	M^3/hr at 50m pressure	1.6
Average running time of mains burst	Days	0.5
Average running time of connection pipe burst	Days	10
Average cost of repairing mains burst	Rand	3 000
Average cost of repairing connection pipe burst	Rand	2 000
Monthly water supplied to the zone or district	Kilo litres	-
Estimated monthly real losses	Kilo litres	-
Purchase price of water from bulk supplier	Rand/m^3	
Selling price of water	Rand/m^3	
Frequency of service connection bursts per 1000 connections at 50 m of pressure	Bursts /1000 conn/yr	2.5
Annual frequency of mains bursts per km of mains at 50 m of pressure	Number/km of mains/yr	0.15
Pressure leakage exponent for flow through mains and connection leaks	-	0.7
Power exponent for calculating number of mains leaks for different pressures (a cubic relationship is normally adopted)	-	3
Cost of basic sounding per km of mains	Rand/km mains	700
Cost of leak noise correlator per km of mains	Rand/km mains	1400
% of mains requiring leak noise correlator to detect leaks	%	20

Pressure Management Model (PRESMAC)

Pressure management is rapidly being recognised as an area where large savings in water losses can be achieved through a relatively low initial investment. The value of “smart PRVs”. has been recognised in Europe since the mid-eighties but it is only in the last 5 or 6 years that the use of such equipment has been accepted elsewhere in the world including North America, South America, Middle East, Far East and now also South Africa.

Pressure Management was first introduced to South Africa in 1999 when four PRV controllers were installed in Krugersdorp (Rabie and Stander, 1999). The purpose of the exercise was to assess the practicality of using such equipment under South African conditions and to try and reduce leakage levels in certain areas experiencing particularly high leakage. Having established that the equipment can be used to reduce leakage, another pilot study was initiated in August 1999 by Johannesburg METRO. The first phase of the Johannesburg Project was completed in February 2000 and the results are fully documented in the project report and summarised in the paper by Mckenzie, Rohner and Wegelin(2000).

The purpose of the PRESMAC Model developed for the WRC is to provide a simple and cost-effective tool for assessing the likely reductions in leakage that can be achieved through a selection of pressure reduction activities. By using the model, a water supply authority will be able to predict potential savings before installing any new equipment (pressure reducing valves with or without the “smart controllers”).

Benchmarking of Leakage (BENCHMARK)

One specific problem that surfaces regularly concerns the manner in which water suppliers express their levels of leakage. It is still common practice to express leakage as a percentage of the water supplied into a particular system or zone. Although this is possibly the most common manner of expressing leakage levels, it is also the most inaccurate and misleading (see Lambert et al, 1999).

A separate project was initiated by the WRC to look into the problem of comparing leakage levels in the various supply systems throughout South Africa. The conceptual design of a standardised approach to leakage benchmarking is now complete and the results are currently being gathered from various water suppliers throughout the country. The approach adopted in the benchmarking project was developed in close co-operation with Mr Lambert.

The outcome of the study is a simple and easy to follow form containing four pages of information. Many of the data entries on the form are calculated directly from earlier information. The form is provided as an EXCEL spreadsheet and is colour coded and protected for ease of use. Full details of the Benchmarking procedure are provided in the papers by Lambert et al (1999).

SUMMARY AND CONCLUSIONS

The potential savings in both water and capital costs through the proper management of unaccounted-for water have been recognised in South Africa for several years. Numerous initiatives have already been taken to control unaccounted-for water and for overall water conservation throughout the country. The latest legislation will ensure that all water suppliers adhere to certain standards and the Department of Water Affairs and Forestry has made its position very clear on the matter in that it will not allow any further developments unless the existing developed resources are being used judiciously.

The Water Research Commission has been actively promoting and supporting research in the fields of unaccounted-for water and water conservation for several years and the results are now being produced. Although technically a late starter, South Africa is now rapidly catching up on other countries and learning from their successes and mistakes in the field of water demand management.

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