



Leakage control - the neglected solution?

Geoff Bridges, Mott MacDonald, UK.



THE MAJOR COMPONENT of unaccounted for water (UFW) in most water supply systems is invariably found to be physical leakage from the distribution system. Not only does this translate into a major loss of revenue for the water utility, but high leakage levels may lead to low system pressures or even intermittent supplies. In some systems water may have to be systematically rationed in an attempt to distribute the available water more equitably. Effective control of leakage and UFW is therefore critical, but frequently it is given insufficient priority.

The range of reported values of UFW in selected countries and major urban systems is very large, as can be seen in Figure 1 (IWSA, 1991; ADB, 1993). Typically, UFW levels in the more developed world are between 15% and 30%, but elsewhere they are more likely to be in the 30% to 60% range. There are exceptions to this, however, notably Singapore with 8% UFW, and Dusseldorf in Germany with 3% (Lackington, 1991).

A feature of all systems that exhibit low values of UFW is that an on-going active leakage control policy is being implemented. This is usually based on waste metering or district metering, supplemented where appropriate by pressure control. In Asia, Tokyo, Hong Kong and Singapore implement waste metering policies whereas in UK most water utilities are now converting to a policy of continuous monitoring. This is effectively a district metering policy integrated with a telemetry system to provide continuous scanning facilities and dynamic simulation of the network. Implications of leakage control on overall system performance are demonstrated in Figure 2.

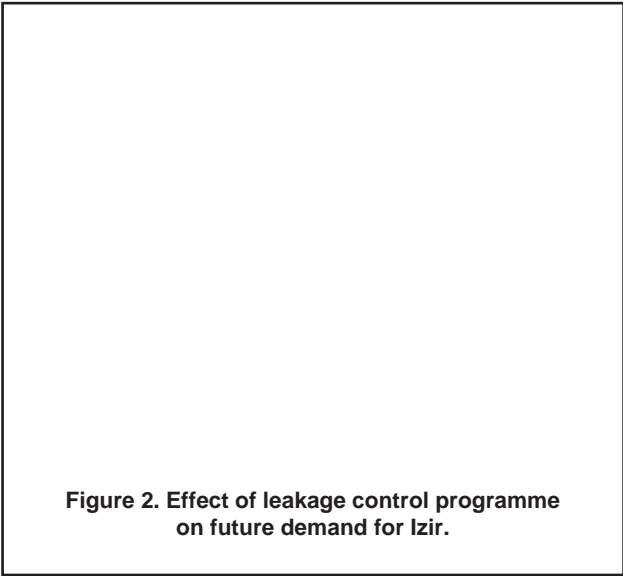
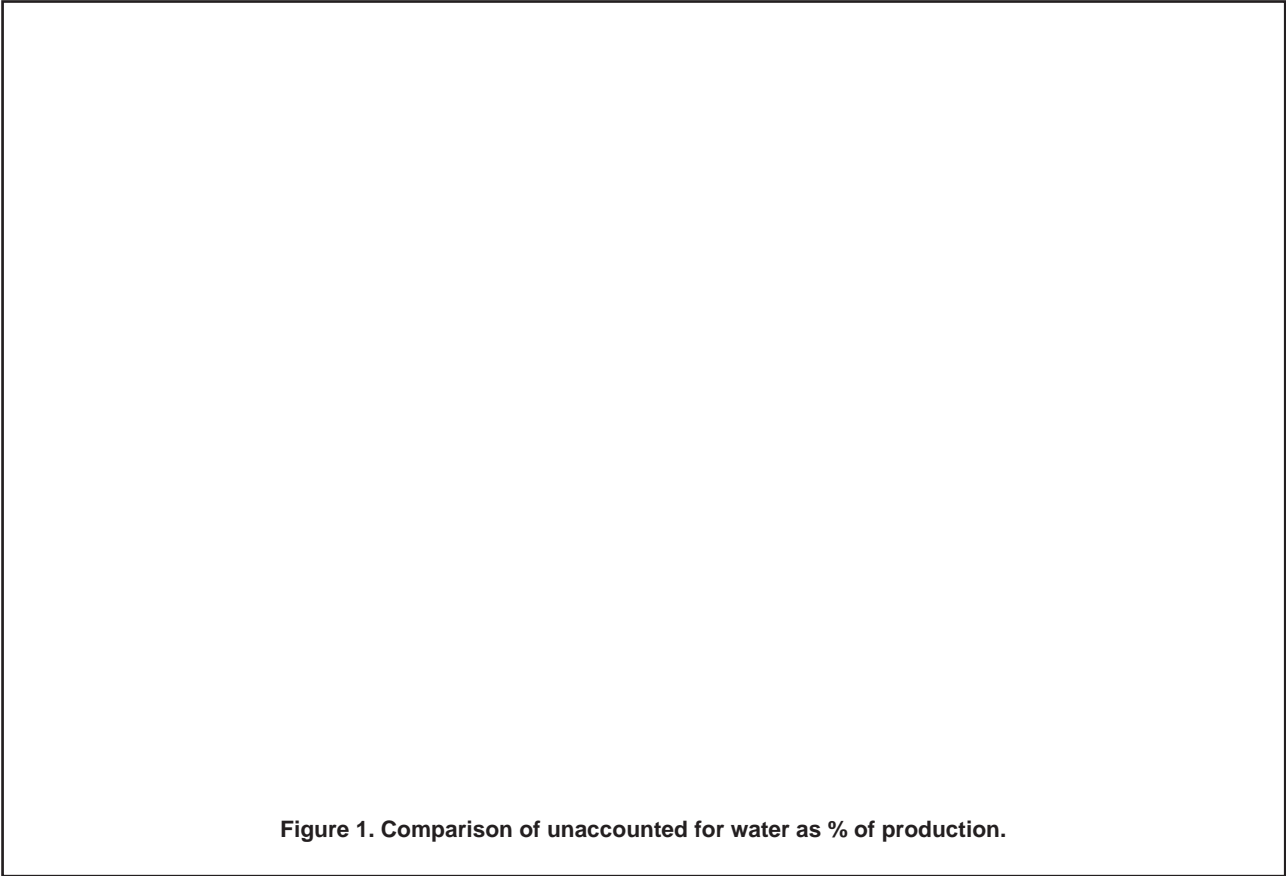
It is a generally recognised fact that the vast majority of leaks and leakage occur on service pipes to consumers properties. In Tokyo 90% of leaks located, accounting for an estimated 80% of distribution system losses, are attributed to defective service pipes (WSA Seminar, 1994). A similar pattern has been found during recent studies in Hong Kong. Recent UK data indicates that service pipe leakage accounts for up to 45% of total leakage in some UK water distribution systems (OFWAT, 1993.) The high incidence of service pipe leakage has prompted some utilities and countries to supplement active leakage control policies with a comprehensive annual mains replacement or rehabilitation programme, with service connections being replaced at the same time as the distribution main to which they are connected. The banning of inappropriate pipe materials, for example unlined galvanised iron mains, and the adoption of newer materials such as polyethylene, which have superior hydraulic and corro-

sion resistance properties, has made a further contribution towards reducing leakage.

In Tokyo, overall annual mains replacement rates of 1.1% have been achieved consistently, with the emphasis placed on cast iron and asbestos cement mains which are being replaced at a rate of 2% annually. Stainless steel is the preferred material for service connections. In Singapore most unlined cast iron mains have been replaced together with 76 000 service connections. The annual mains replacement rate is 0.5% (Water Malaysia, 1992). The average age of the pipe networks in Japan and Singapore is therefore relatively young. In some German and Dutch systems annual replacement rates of up to 3% are not uncommon, the average age of such systems being of the order of only 25 years, influenced by major infrastructure reconstruction following World War II. Minimal leakage control effort is expended in systems where high renewal rates are achieved. There is very little published evidence to support the economic justification for such high annual renewal rates which, although leading to low leakage levels, are reflected in considerably higher water charges. The philosophy appears to be that the achievement of low levels of leakage is alone sufficient justification. High replacement rates can only be entertained in relatively affluent parts of the world.

The question therefore remains as to what can be practically done to reduce the high levels of UFW and leakage that characterise many systems in the developing world. Active leakage control policies tailored to the local situation have been proven to be cost-effective throughout the world. The skill lies in selecting the optimum policy and determining the amount of effort to be put into its implementation to provide a positive economic balance, ie the cost of policy implementation must be less than the value of the water saved. However, despite the cost-effectiveness of leakage control programmes political considerations may influence technical solutions to improve service levels.

For instance, instead of implementing a cost-effective leakage control programme to improve supplies to consumers, emphasis may be placed on a higher profile capital works scheme to demonstrate that the utility is taking positive action to tackle the problem. However, the construction of a new treatment plant to increase the supply of water to deficient areas is only likely to provide temporary relief unless the underlying leakage problem is tackled. In fact, just the opposite effect to that desired is likely to be achieved, as pressures will rise when the new water supply is commissioned, causing more leaks to



The commitment of large amounts of funding for capital works programmes demonstrates that there is a willingness, and that the financial resources are available, to tackle the real problem if only the credibility gap to promote leakage control programmes can be bridged. Furthermore, the major financial and resource investments in temporary measures, such as the tankering of supplies to affected areas and the willingness of consumers to pay for such tankered deliveries at rates well above the normal water tariff, reinforces this assertion. For instance, in Karachi there are more than 1 000 tankers delivering water during daylight hours to water stress areas in which consumers may pay private contractors up to ten times the tariff rate for the water delivered. The solution being implemented now in Karachi is to progressively develop an active leakage control programme to provide short term improvements and to initiate a longer term leakage control strategy in conjunction with the development of a major new water supply system to serve the city in the medium term. This complementary approach can be very effective as leakage control policies can be implemented much quicker and cheaper than capital works programmes (these may be required anyway to meet projected shortfalls in system capacity even with leakage control).

It must be recognised, however, that although a leakage control policy may be justifiable economically, it may not be practicable to implement. This is the current situation in Karachi and Colombo, where passive control and

develop and leakage from existing leaks to increase. As an example of this, when the Ngagel III plant extension was commissioned in Surabaya, Indonesia, a few years ago, it was found that less than 5% of the additional water supplied was registered on consumer meters, the majority being lost through increased leakage (Surabaya Unaccounted Water Study, 1988). Subsequently, an appropriate leakage control policy was implemented, followed by initiation of a major system rehabilitation programme.

visible leak inspections, supplemented by sounding, are being implemented despite the greater economic benefits of more intensive zonal metering policies. Until such time as service pressures and supply continuity can be improved sufficiently, then these optimal policies will remain longer term strategy goals.

UFW and leakage control programmes require a major investment in human resources as they entail fairly labour intensive activities despite the development of modern detection equipment. By necessity an intimate knowledge of the distribution system is required to operate such programmes efficiently. In addition, some activities can cause considerable disruption to consumer supplies (for example valving operations to temporarily create waste zones or to undertake step tests). Leakage control activities should normally, therefore, be undertaken by utility staff as part of routine O & M activities. A recent development has been the appointment of contractors and consultants to reduce UFW, with payment being made on results achieved. Such an approach requires care to be taken to avoid making disproportionate payments for the work undertaken, but at the same time providing incentives to encourage good performance.

Water utilities must recognise the importance of leakage control through the appointment of suitably experienced staff at the highest level of management, supported by capable staff within a permanent institutional structure. It is essential for competent and well motivated staff to be attracted into the work not only to maintain the high calibre of technical expertise and commitment required but also to minimise staff turnover. In practice it is not unusual for leakage staff to be transferred from their normal posts to fill vacant posts that are deemed to be more important within the utility. Similarly, the allocation of unsuitable staff simply to fill the required staffing complement must be avoided. The whole ethos of the UFW/Leakage Control Department, as well as that of the top management level within the utility, must be such as to encourage commitment, motivation, and the determination to maintain an effective and continuous effort to control UFW and leakage. This will be reflected in the investment in personnel, training, specialist equipment, management information systems, etc.

UFW and leakage control may not be glamorous areas of work within the utility but they are extremely important nevertheless and can make a major financial impact. For instance, if the level of UFW in Colombo could be reduced to 25% of production, that would be equivalent to saving up to half the capital cost of the 182 Megalitres per day Ambatale plant extension recently commissioned at a total cost of nearly Rupees 2100 million (Rupees 48.7 = US\$ 1 at May 1994). Furthermore, the recurrent annual costs of treating and pumping the additional water saved would also be eliminated.

Mott MacDonald has undertaken many leakage control projects in countries as diverse as Oman, Turkey, Mozam-

bique, Indonesia, Malaysia, Pakistan, Abu Dhabi, Hong Kong, China and currently Sri Lanka. In all of them appropriate leakage control strategies have been developed and have been proven to be cost-effective. The activities in such programmes, however, must be maintained if the improvements gained are not to be lost as a result of continuing system deterioration. Leakage control must therefore be viewed as a major component of the regular operation and maintenance activities undertaken by the water utility, with fully dedicated and well trained staff allocated to monitor, detect and control it. Funding agencies, and increasingly the utilities themselves, recognise the effectiveness and relevance of perpetual leakage control programmes, in particular where labour costs are relatively inexpensive and water is scarce or expensive to produce and distribute. Too often in the past, however, the impetus and benefits achieved from specific leakage control projects have been lost afterwards due to reduced commitment from water utilities.

Major benefits are obtainable using relatively simple techniques and inexpensive equipment initially, before progressing to more sophisticated approaches. Simply locating and repairing visible leaks promptly will provide invaluable preparation for initiating a more comprehensive policy. The key to success is the commitment and motivation within the utility to tackle the problem effectively, from the highest level of management downwards. The task may not command a high profile or receive public accolades, but it can be as effective as a major capital works programme. In view of the increasing demand for water and its scarcity worldwide greater emphasis must be given to leakage control and UFW programmes if we are to avoid major problems in the future. We neglect it at our peril!

References

- 'International Report on Unaccounted for Water and the Economics of Leak Detection', IWSA Seminar, 1991.
- Lackington D W, 'Leakage Control, Reliability and Quality of Supply', Civil Engineering Systems, 1991, Vol 8.
- 'Leakage Control and Distribution Management: Lessons from Japan', Water Services Association Seminar, UK, March 1994.
- 'Surabaya Unaccounted Water Study, Final Report', Mott Macdonald, 1988.
- 'The Cost of Water Delivered and Sewage Collected 1992-1993', Office of Water Services, UK, October 1993.
- 'Water Malaysia 1992, 8th ASPAC - IWSA Regional Water Supply Conference and Exhibition, Technical Proceedings', Kuala Lumpur, October 1992.
- 'Water Utilities Data Book, Asian and Pacific Region', Asian Development Bank, -Manila, November 1993.