


Keith Richardson and Roger Harris
Urban Water Supply Systems - The Repair Option
ABSTRACT

Faced with a neglected, malfunctioning, inefficient or broken down water supply system there is a temptation to overlook the repair option in favour of replacement. Considerable savings can be achieved through well conceived repairs or improvements. Additionally the efficiency and treatment capacity of existing works can often be significantly improved by introducing new management or operational techniques.

INTRODUCTION

Now halfway through the International Drinking Water Supply and Sanitation Decade launched by the United Nations, it is generally recognised that the cost of meeting the Decade's objectives will be many times more than was originally expected. In the present climate of worldwide economic difficulties it is therefore becoming increasingly important to identify means of reducing the costs of providing these essential public health services in order that the limited available funds can be used to benefit the greatest number of people.

Much has been done in this respect in Tanzania and our firm was privileged to be engaged by the Ministry of Lands Housing and Urban Development in 1979 to execute the Dar es Salaam Sewerage and Sanitation Master Plan and Feasibility Studies. Two other papers being presented at this conference relate to some of the key recommendations emerging from these studies - the low cost sanitation programme and the technical assistance programme to establish the proposed new management organisation.

Howard Humphreys are currently project managing the major rehabilitation of the existing sewerage in Dar es Salaam, whilst in Kenya they are responsible for the Nairobi Water Supply Project, the latest stage of which includes the review and repair recommendations for some of the existing facilities in addition to the provision of new capital works. The authors are involved with both of these projects.

This paper sets out to provide guidelines as to how improvements can be made to existing urban water supply systems at relatively low cost through the adoption of a repair and improvement strategy as opposed to one of renewal. The benefits to be attained by such a strategy are twofold, the reduction of operational costs and the deferment of capital expenditure. It must be recognised however that physical improvements alone will not produce or maintain optimum capacity/production and that equal importance must be given to the need for operational management improvements.

A water supply system comprises three operational areas, distribution systems, trunk mains and treatment works. The following guidelines and case studies are therefore presented in relation to these groupings.

DISTRIBUTION SYSTEMS

As the demand for water in urban areas increases the new sources are carefully planned but the extensions to distribution systems tend to occur in a piecemeal fashion. There is therefore usually much scope for improvement of these systems at low cost in order to improve efficiency and/or provide additional capacity to meet projected increases in demand.

An important preliminary to the preparation of an improvement programme for a distribution system is the acquisition of 'as constructed' or record drawings together with reliable data on consumption, pressures, and variations in reservoir storage usage. Such data is not only essential for good day to day management of the distribution systems, it also ensures that improvements are planned in sufficient time.

The first phase of an improvement programme would comprise the installation of district meters, to accurately determine, the overall consumption the installation of accurate level recorders on all service reservoirs, and pressure and flow surveys of all districts to determine daily peak and minimum flows. This work should be followed up by analysing the distribution system using network analysis techniques.

Once an analysis of the system has been carried out a phased programme of improvements to the system to meet increasing demands can be implemented and would typically be along the following lines:-

- a) Adjust pressure zones where necessary to keep pressures to the minimum compatible with providing an adequate pressure to properties. Install additional pressure control valves where necessary.
- b) Choose key pressure points in the system and install pressure recorders.
- c) In each district set up waste water zones.
- d) Introduce additional valves and short link mains to ease operational problems and facilitate the setting up of waste meter and pressure zones.
- e) Assess the true cost of water in each district, and use these values to prepare waste prevention operational guides.

- f) Consider the installation of booster pumps or pneumatic booster systems for small high level zones as these can be cheaper than new mains.
- g) Standardise equipment, particularly in pumping stations to ease maintenance problems.
- h) Review bye-laws.
- i) Consider the provision of storage by industrial users. This not only safeguards their supply but reduces peak demands and hence size of main.
- j) Interconnect systems to provide alternative supply in case of emergencies.
- k) Review service reservoir requirements and ensure effective use is being made of the them. These not only help to reduce peak flows, but give cover at times of emergency due to major failure. Independent high level inlets at service reservoirs although more expensive help to give better control.
- l) Optimise the usage of pumps to effect power saving.

Regular night flow assessments in each district and waste zone will allow staff to concentrate their efforts in areas where there should be the best return. Unsatisfactory trends are identified before major troubles arise. The provision of good data will enable the distribution system to be better managed and improvements to be designed based on knowledge of what actually happens rather than what is thought to happen.

It is difficult to generalise on the savings which can result from carrying out such improvements to a distribution system, but the reduction in wastage and more efficient use of the existing system must result in a delay in the need for new capital works, and therefore be measures which are worthy of thorough examination before proceeding with new capital schemes.

TRUNK MAINS

The sources of supply for many towns and cities are frequently some considerable distance from the area being supplied. Consequently large diameter pipelines have been laid to transfer water from the source to the distribution system. These pipelines represent considerable capital investment and any loss of capacity is a matter which needs serious investigation. The problems associated with the deterioration of mains are summarised in the table below.

<u>Problem</u>	<u>Effect on Water Mains</u>
Encrustation	Reduced carrying capacity. Increased friction head in pumping mains.
Corrosion	Reduced strength Discolouration Leakages and bursts.
Accumulated deposits or coatings	Water quality problems Reduced carrying capacity Increased pumping friction head.

The materials from which the mains are made clearly has a considerable influence on their performance as not all materials are subject to the problems given above.

The five principal materials used for water mains are iron, steel, asbestos cement, unplasticized polyvinyl chloride (uPVC), and prestressed concrete.

The uPVC, asbestos cement and prestressed concrete pipelines do not normally give rise to problems because of reaction of the material with water. This is not so with steel and iron pipes where the natural tendency is to revert to iron oxide which is the cause of many water main problems. In all cases build-up of deposits can occur from poor treatment control or from old iron pipes upstream.

Once these problems have begun then consideration must be given to the feasibility of carrying out renovation of the pipeline. Generally, partic-

ularly in developing countries where labour costs are relatively low, it is cheaper to renew small diameter mains. Large diameter mains may however be renovated economically using methods such as:-

- a) Swabbing - cleaning out deposits by passing through foam swabs.
- b) Pressure jetting - removes deposits and some encrustation.
- c) Air scouring - removes deposits and some encrustation.
- d) Scraping and relining - the linings can be of concrete, bitumen and epoxy-resin.

The use of these renovation techniques in the right circumstances can restore a trunk main to almost full carrying capacity again.

WATER TREATMENT WORKS

Generally water treatment works, particularly those for large urban communities have been designed and constructed to a high standard. Frequently however it is found that they are not able to be operated at the designed capacity. Rarely is the fault found to be due to structural weaknesses, but rather it is due to lack of operational experience and poor maintenance of electrical and mechanical equipment.

Recent inspections were carried out of three treatment works in East Africa all of which were unable to produce more than 85% of design capacity during a period of good raw water quality. The findings of these inspections are summarised below:-

Works No. 1

A works rated at 60,000 m³/day, with treatment consisting of sedimentation, rapid gravity sand filters, chlorination and pH corrections.

The faults found were:

1. Air scouring of filters was not possible - resulting in clogging up and reducing capacity.
2. Broken penstocks on the filters - lack of capacity.
3. Alum dosing - not working properly giving reduced capacity.
4. Flow meters for dosing and backwash pumps not working - control of further backwash rates and chemical dosing not reliable resulting in reduced capacity.

The estimated cost of all these repairs was £22,000.

Works No. 2

A works rated at 5,000 m³/day with treatment of spring sources by microstraining and chlorination. The plant was 26 years old.

The faults found were

Damaged straining fabric
Wash water pumps not working

The cost of repair is estimated at £11,000. The alternative of replacing with slow sand filters would have cost £150,000.

Works No. 3

A works approx. 50 years old with full treatment - i.e. filtration, sedimentation and chlorination.

The faults found were

Restricting flows on inlet pipelines
Washwater pumps and alum dosing pumps not working (16 years old).

Local water supply pump and trunk main flow meter - not functioning.
Estimated cost at £19,000

In all the above examples the costs of repair are minimal compared to the costs of replacement. Where problems on treatment works are not so readily identifiable, alternatives such as conversion of existing works to another type of treatment e.g. change of filter

media are worth examining in depth. Where problems occur with river or reservoir sources due to algae, jetting in reservoirs and microstraining are possible solutions.

CONCLUSION

Our experience has shown that in many instances considerable savings can be achieved by repairing existing assets as an alternative to renewal.

Although renewal cannot always be prevented or deferred over a long term a significant deferment will normally make repairs and improvements an economic option.