WATER SUPPLY AND SANITATION: HOW HAVE AFRICAN CITIES MANAGED THE SECTOR? WHAT ARE THE POSSIBLE OPTIONS?

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ABSTRACT

Water shortages during the last decade prompted the City of Bulawayo to put in place water conservation programmes which reduced water consumption and became part of the ethos of the city. Lessons learned are shared.

Given the pressures on the world fresh water resources, implementation of Integrated Water Resources Management is a responsible way of managing Urban Water Supplies and Sanitation. Reuse of water should be integrated in the total water supply strategies. An enabling environment should be created to enhance the reuse of water.

Many water supply and sanitation systems are in a deplorable state due to insufficient upkeep that is exacerbated by shrinking development aid. To respond to this challenge, there is a need to engage the private sector through Public Private Partnerships in order to move towards sustainability.

Performance shortfalls in the management of water supply and sanitation should be reduced through effective performance indicators and benchmarking programmes.

1. INTRODUCTION

The International Drinking Water and Sanitation Decade 1981 – 1990 has came and gone. Many gains were made during that decade. Many countries in Africa were only able to extend service coverage at a rate commensurate with national economies and population growth. Limited resources for the poor cities at least provided something for all instead of everything for a few. But lessons were learnt.

The lessons of the decade were that firstly water accessibility and shortage is still acute in some poor towns and cities in countries of the South, which include Africa. Secondly the water and wastewater facilities in themselves are not sufficient and must be accompanied by parallel investments in their management if benefits are to be maximised.

In place of the Water Decade has come the Africa Water Vision for 2025:

“An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional co-operation and the environment”.

Africa is experiencing the most rapid rate of urbanisation in the world. A large number of cities and towns on the continent are facing a major challenge of endemic
poverty and under development. The crucial role of water and sanitation in accomplishing socio-economic development goals is widely recognised.

Some parts of Africa appear to have an abundance of water resources yet others are faced with perennial droughts and pervasive water shortages. Water has become one of the most restrictive factors to socio-economic development.

One of the challenges facing most African cities therefore is the provision of adequate and sustainable water supply and sanitation services to the urban dwellers amongst which are the poor. Here the poor are those whose annual income is below their national living wage or poverty datum line.

2. BACKGROUND

During the Decade reliance was made on the supply side of the water supply/demand equation – find and build a new source of supply to satisfy everybody’s demand. However, there has been a paradigm shift. Throughout the African continent, urban centres, particularly major cities, are experiencing phenomenal growth in population which in the majority of cases is not matched with available infrastructure to provide water and sanitation for all.

It was estimated that between 1990 and 2020, Africa’s population is likely to double. The forecast is that there will be large migrations within and across national boarders accompanied by heavy movement to large urban settlements. In 1995, the Economic Commission for Africa had estimated that almost half of Africa’s population twenty years from then would be urban. The African Continent is indeed a region in rapid transition to urbanisation. In many African Countries the previous urban minority will soon make up a majority of the national population. These phenomenal increases will call for huge extensions of services – health, housing education, water and employment creation.

There has to be a shift in emphasis on the water/demand equation. The supply oriented approach has failed to deliver water equitably, efficiently and sustainably. The cost to develop a new water source is often two to three times the cost of current sources. The focus, at the millennium shift, is to manage the demand side of the water supply/demand equation.

The catch phrases of the new millennium are water security, sustainable development, water governance, networking, integrated water resources management, private/public participation, water demand management, benchmarking. Lately, technology is no longer the principal constraint. The constraints lie elsewhere and include the role of public policy, fiscal measures, venture funding, social and cultural barriers and other cross cutting issues.

Clearly there is a shift from inherited water supply and pollution oriented approaches to sounder water resources management. Focus is shifting towards making the best outcome of water already accessible and towards intersectoral reuse and recycling for augmenting diminishing fresh water supplies.

Water is now acknowledged as a major limiting factor in the socio-economic development of a world with a rapidly expanding population. The United Nations Millennium Declaration draws attention to the importance of water and water related activities in supporting development and eradicating poverty. The Declaration also emphasise a new ethic in all environmental actions of conservation and stewardship and to stop unsustainable exploitation of water resources by developing water
management strategies at the regional, national and local levels which promote both equitable access and adequate supplies.

In the context of African urban towns and cities it is absolutely fundamental that the water’s role as an engine for development be properly understood amongst city managers and senior executives. Water challenges are very different in the different regions of Africa i.e. regions with equatorial climate, regions with limited rain season and regions with numerous dry spells and long dry seasons. Water management strategies will therefore vary in the different regions of Africa.

3. WHAT THEN HAVE BEEN THE TRENDS FOR MANAGEMENT OF URBAN WATER SUPPLY AND SANITATION SERVICES IN AFRICA?

In order to better understand the issues involved in urban water and sanitation management, the experiences gained by the City of Bulawayo, in Zimbabwe are shared. I contend that the issues are not only relevant to Bulawayo but to many other urban centres in Africa as a whole.

Cities are complex organisms depending on various independent networked services to survive. They have roads designed to ensure smooth traffic flows; telephone networks which help speed communication while reducing the need to drive to places to convey messages; they rely on effective postal services but by far the most important and unfortunately least conspicuous networks are water supply networks including associated urban sanitation networks. And most unique about these is the possibility that they may not always carry “happy messages” as they can also deliver with them a host of diseases carrying agents through contaminated or poorly treated water. Sanitation networks if poorly operated are capable of toxifying the city resulting in significant medical and primary health costs to the city.

Although the focus of this paper is on Urban Water and Sanitation Management, it is necessary to gain a wider appreciation of the water sector in order to understand the particular issues of urban water in Zimbabwe.

In Zimbabwe the Government enables and regulates the private and community sectors rather than directly provide services. Government plays the indirect role where it retains responsibility for ensuring that public services are provided without actively providing them directly. Through the recently established Zimbabwe National Water Authority, it promotes efficiency though the adoption of more competitive and business like practices of reducing the burden on Government, of breaking up unresponsive public sector monopolies and of giving more control to citizens or the users of the services.

The Government is advocating: -

♦ Full privatisation of water supply
♦ Decentralisation of water supplies to local levels of Government or communities.
♦ Creation of ‘arms length’ public corporations to manage bulk water supply.
♦ Contracting out of the management of water supply and contracting in private finance.

Local authorities in Zimbabwe are relatively autonomous. In the context of water supply and sanitation, activities have been unbundled and formulated into parts which can be classified in the case of Bulawayo as policy issues, legislation, technical issues and public education and awareness. Local authorities play the
‘direct’ role of delivering water and sanitation services with larger urban centres assuming a high level of responsibility and rural districts having their water managed on their behalf by the Zimbabwe National Water Authority.

The direct administration of water supply and sanitation at local level has been fairly successful. It has maintained high quality and high and extending levels of coverage. Good cost recovery has been achieved. Local supply is almost self-sufficient in terms of finance and administrative systems. In the case of Bulawayo, it has coped with severe drought where municipal ownership has allowed successful appeal for the support of citizens and businesses.

Bulawayo’s water is managed by a department of City Council but within the national system. There are policy issues that guide some over-riding commitments in the management of water supplies:

♦ All citizens should have access to affordable potable water.
♦ Equal level of service throughout the city – the ‘one city’ concept.
♦ The water account, including investments, should be self-financing at least on the basis of historic cost accounting but with an increasing appreciation that this should be on the basis of long run marginal cost.
♦ Acceptance of principle of reuse of water
♦ Application of a permanent rising Block Tariff structure as the most important water management tool to curb excessive water demand.
♦ Application of a very punitive tariff for households consuming more than 31kl per month.

The new Water Act (1998) sufficiently empowers urban activities to address the conservation of water, the regulations allow for the introduction of water restriction in situations of water shortages. Urban centres can also promulgate Bye-Laws, which are legally binding to all consumers. Supportive legal frameworks are in place to control and regulate the sector.

**MANAGEMENT OF EXISTING SOURCES OF WATER FOR MAXIMUM EFFICIENCY IN THE CITY OF BULAWAYO**

**Surface Water**

Bulawayo is located West of Zimbabwe in a region with limited rainfall and numerous dry spells and long dry seasons. Water supply for the City is based on surface water accumulated in reservoirs. The reservoirs are operated on an integrated basis by abstracting water from dams with less favourable evaporation characteristics first and then dams with better characteristics in order to reduce overall losses through evaporation to a minimum.

A dedicated computer program is used to decide on the dams from which to abstract water on daily basis based on the evaporation characteristics of the reservoirs. Generally, with most water abstracted from the reservoirs with the largest surface area from which maximum evaporation takes place.

Operating the system for maximum efficiency in that fashion minimises evaporation losses and increases the average safe yield that can be made available to the city.

Surface water is used during periods of ample supply while ground water is used as back up system during the drought. This is called conjunctive use of water. This is a
useful tool for managing water supplies. Ground water is not susceptible to evaporation, so while the dams have enough water, less ground water is mined. Ground water is used more during times of water shortages.

Integrated catchment management is also practised in the supply dams catchment. It is beneficial to research and understand the relationship between good land management, silt load into the dams as well as the construction of small dams in upper catchments. During the worst drought in living memory in the years 1990–92, Bulawayo almost ran dry—at some stage the city had 21 days supply left before the heavens opened up and there was substantial run off to avert a major water supply catastrophe. It did not take long for the ill informed to demand that the small dams constructed as silt traps in the upper catchments be destroyed. The Water Engineers’ skills at explaining integrated catchment management was put to the test and they won the debate which in the Zimbabwean context tended to be linked with the colonial era and its machinations.

It is important to have information on land usage and application within the catchment areas to effect proper catchment management.

WATER QUALITY STATUS IN BULAWAYO

Water supply sources for the city are located on a different catchment to the one that receives treated sewage effluents. The catchment area for the supply dams is relatively free of pollution from industrial sources since little industrial activity takes place. The rain water from these dams is generally soft.

Surface water is prone to high turbidity particularly in the rainy seasons. There is now a new concern that threatens to adversely affect the quality of rain water stored. This is the advent of illegal gold panning along some of the rivers in the catchment areas. Loosened soil from gold panning is carried into the dams where not only siltation takes place but also the turbidity in the water is increased. This tends to increase treatment costs as more chemicals are consumed during the treatment process.

Present legislation in Zimbabwe remains silent on the subject of detailed requirements for drinking water other than that water intended for drinking must be wholesome. The City of Bulawayo, in the absence of comprehensive national legislation on drinking water quality standards, has adopted the South African Bureau of Standards No. 241.

These specifications are shown in Table 1 below:

<table>
<thead>
<tr>
<th>Chemical Characteristics</th>
<th>Expression of Results</th>
<th>Highest Desirable Level</th>
<th>Maximum Permissible Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH Chloride</td>
<td>mg/l CL</td>
<td>7.0 to 8.5</td>
<td>6.5 to 8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25</td>
<td>150</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/l SO₄</td>
<td>25</td>
<td>250</td>
</tr>
<tr>
<td>Nitrates</td>
<td>mg/l NO₃</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>Nitrites</td>
<td>mg/l NO₂</td>
<td>0,001</td>
<td>0,10</td>
</tr>
<tr>
<td>Ammonia</td>
<td>mg/l NH₄</td>
<td>0,05</td>
<td>10,50</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/l Ca</td>
<td>75</td>
<td>100,0</td>
</tr>
<tr>
<td>Conductivity</td>
<td>US CM-1 at 20°C</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/l Mg</td>
<td>30</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>------------------</td>
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<td>-----</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg/l Na</td>
<td>20</td>
<td>150</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/ K</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Colour</td>
<td>TCU</td>
<td>5 Units</td>
<td>15 Units</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>5 Units</td>
<td>5 Units</td>
</tr>
</tbody>
</table>

The City of Bulawayo has managed to treat water supplied to its residence to International Standards.

The City also obtains some of its water from an aquifer some 40km to the North. Underground water is mined from this aquifer during drought periods. This underground water is only chlorinated and blended with treated water from the supply dams in the service reservoirs. The underground water is hard but blending reduces the overall hardness. Fortunately blended water is supplied to residential areas only and so the increased hardness does not affect any industries.

**WATER CONSERVATION IN BULAWAYO**

During the 1990-92 drought, the water supply was very critical. This triggered frantic efforts to save the city. Numerous water augmentation and conservation schemes were hatched. The following are worth noting:

♦ Public campaigns for water conservation by using the press, radio and television.
♦ Hose pipes bans
♦ Stringent water rationing
♦ Aquifer project
♦ Water reuse
♦ Extraction of dead water in the supply dams

In conceiving the above strategies, the consequences of there being no water in the reticulation system were clear not only to the city authorities’ minds but also in the minds of all citizens, the business fraternity and the industrialists. Everyone was made aware of the danger and activities outlined above were an all out effort by stakeholders to save the situation.

Bulawayo has had to learn the hard way the need to ensure good management of water. With this background the city has adopted a number of options for sound water management. These include: -

♦ Leak detection and reduction
♦ Further recycling of treated sewage effluent
♦ Conjunctive use of surface and underground water sources
♦ Introduction of trade effluent tariffs as a compliment to economic pricing of water

**WATER RE-USE STRATEGY**

That Bulawayo is located in a drought prone region was recognised many years ago. Consequently, from 5 out of 6 sewage treatment works; the final effluent is treated to a standard appropriate for reuse on suburban parks, golf courses, nurseries, schools and sports clubs, playing fields and various community run sports fields. Without reclaimed water, all these facilities could have made a claim on potable water. From the biggest sewage treatment works, the final effluent and sludge are applied to crops and to raise pasture for a thriving beef herd.
Plans are in hand to extend the reclaimed water distribution system, which is separate from the potable water distribution system.

The reclaimed water has also been used to establish a community run woodlot and sludge used to grow pasture for a 300 Angora goat herd and the growing of a 30 hectare of land for eucalyptus trees.

**THE PRICE OF WATER**

The city adopted a rising block tariff structure in 1992. The rising block tariffs were used as a tool to curb excessive water demand in the domestic sector. The charges for water appear to exceed most people’s willingness-to-pay. Cheap consumption is limited to 600 litres per household per day or 18 Kilo litres per month. The general thrust of Bulawayo’s reforms since 1992 drought has been to increase both the efficiency and the equity or fairness of provision. Rationing had a reforming effect. On the other side of equity, a universal ration of consumption per household was established to cover basic needs; above that level it was mainly the better off who were affected.

4. **AVAILABLE POSSIBLE OPTIONS FOR MANAGING WATER AND SANITATION**

**INTEGRATED WATER RESOURCES MANAGEMENT**

There are a number of options available for managing our situations when demand is anticipated to exceed capacity. Integrated Water Resource Management is discussed in detail. Water Demand Management, wastewater reuse and artificial recharge of ground water form part of the integrated approach. In line with the theme of this workshop, Public Private Partnerships are also discussed.

In the natural water cycle, a mere 1% of water on Earth is available to accommodate human development needs. Mankind has significantly altered the natural water cycle by interventions like:

- Building of large dams
- Diversion from rivers for human uses
- Pollution and mining of groundwater
- Return of inadequately treated or untreated waste water to streams.

The rising demands for water for irrigation, domestic consumption and industry are leading to competition over the allocation of the scarce water resources. To avoid a crisis our countries must conserve water, pollute less, and manage supply and demand and perhaps slow population growth.

Apart from the direct problems of water shortage, there are other implications of diminishing supplies. The cost of expanding existing supplies or developing new sources are expected to increase as the limits of conventional water sources are approached. Water will have to be imported over long distances and/or high elevations. The Gauteng area in South Africa, Gaborone in Botswana, Bulawayo in Zimbabwe, Accra in Ghana, Blantyre in Malawi and Windhoek in Namibia are typical examples.

In these circumstances, intervention into the natural water cycle will have to be managed in an integrated fashion. The following definition of Integrated Water
Resource Management is important within the context of integrated resource management:

“Integrated Resource Management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic commodity, the quantity of which determines the nature of utilisation. Thus water resources have to be protected taking into account the functioning of aquatic ecosystems and the nature of the resources in order to satisfy and reconcile needs for water in human activities. In developing and using water resources priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however water users should be charged appropriately (Rio 1992)“.

5. WATER DEMAND MANAGEMENT

Water demand management involves measures that improve efficiency by reducing water use or alternative patterns of water use after abstraction. Examples of demand management include conservation-oriented pricing, water fixture and plumbing standards and retrofitting, water efficient landscaping, changes in water use practises and public education.

Implementation of Water Demand Management to achieve conservation’s full potential is novel. Water Demand Management curbs demand and delays the need for implementing the next water scheme. It is more cost effective than supply augmentation. In Zimbabwe, the City of Bulawayo has pioneered Water Demand Management as a water resource management tool.

WHY WATER DEMAND MANAGEMENT?

Urban centres in Africa are exploding with population increases. Future population will equally exert additional demands on water resources. Many are still unserved by accessible and potable water. Future development of supply sources will be very costly especially in this era of shrinking development aid and national budgets. The demand, both present and future, must be reduced to cope with the supply/demand imbalances. This is where Water Demand Management will play a major role.

There are some disadvantages such as reduced revenue but these are nothing compared with the benefits which include water savings, deferment on capital investment on new resources, reduction in costs of treatment and pumping of existing sources (which are short anyway), improved consumer satisfaction resulting from greater availability of water and more constant supply. By the time Water Demand Management is put in place, there will be increased knowledge and consequently more efficient use of the existing distribution network. Less water will be discharged to Municipal sewage treatment works. Water Demand Management has a positive environmental impact just by minimising the need to construct water supply facilities. The less the water used the more the water available for aquatic mammals and bird life in the rivers and lakes.

The implementation of Water Demand Management has cost implications. Leak detection/reduction requires field investigations and usually the purchase of leak detection devices, the capital costs of new fittings on pipes as well as the cost of labour. These costs are less than water supply augmentation though.

There are several practical methods of achieving desired levels of water savings. Through networking, practical experiences from other parts of the world could be imported to achieve water savings.
Five methods of achieving water savings were suggested in the study for Urban Water Demand Management in Southern Africa. These are:

- Reduced unaccounted for water
- Reduced industrial demand
- Reduced domestic demand
- Reduced commercial/institutional demand
- Reduced drought – period demand

Unauthorised unaccounted for water (UFW) is a serious problem facing Urban Water supply systems. Samples of water losses reported in various cities in Africa range from 25 – 57%.

Table 2 below shows UFW in selected cities as a percentage of total water supply.

<table>
<thead>
<tr>
<th>Location</th>
<th>Unaccounted For Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretoria, South Africa</td>
<td>21,8</td>
</tr>
<tr>
<td>Johannesburg, South Africa</td>
<td>12,8</td>
</tr>
<tr>
<td>Bulawayo, Zimbabwe</td>
<td>22</td>
</tr>
<tr>
<td>Monte-video, Uruguay</td>
<td>40</td>
</tr>
<tr>
<td>Oslo, Norway</td>
<td>38,1</td>
</tr>
<tr>
<td>Paris</td>
<td>20,6</td>
</tr>
</tbody>
</table>

Methods of reducing unaccounted for water include leak detection and repair, block rate billing and reduction of water theft.

Table 3 shows areas to be addressed by the UFW reduction method.

<table>
<thead>
<tr>
<th>Area</th>
<th>Issues</th>
<th>Actions</th>
</tr>
</thead>
</table>
Old reticulation systems, unsuitable pressure, inadequate operation and maintenance budgets, lack of resolve and motivation and lack of detection equipment lead to frequent and costly leaks. Worldwide distribution system efficiencies are estimated to be about 40–60%.

Leak detection and repair can be accomplished by private contractors. Management contract schemes seem to be appropriate for larger urban centres not only for repairs but also for improved bills collection.

Block rate billing also results in water saving besides achieving saving costs in treating and distributing water. Full cost recovery and 100% metering are absolutely essential to good management and water conservation for municipalities.

Tariff setting needs to be addressed carefully as it is often politically sensitive to implement and economically difficult for the poorer water users.

Billing for wastewater treatment costs based on volume of effluent and sewage strength is also essential. The water rates should be calculated so that users pay full costs for level of service. Water savings result from full metering. Generally per capita consumption is higher in those cities without full meting than in those with full metering.

Reducing water theft is possible but difficult to enforce. Industrial, commercial and residential users might steal water. Commercial and industrial illegal users are easier to control than domestic ones who could be actually dangerous. Monitoring teams, public education campaigns and reporting by other concerned consumers and citizens can reduce water theft.

Reduced industrial demand could be reduced by encouraging reuse measures. 80% of Mexico's dry season irrigation comes from wastewater reuse. In Beijing reuse of industrial water rose from 46% in 1978 to 72% in 1984 while industrial output

<table>
<thead>
<tr>
<th>Leakage</th>
<th>Poor quality pipe &amp; installation</th>
<th>Leakage in reservoirs &amp; mains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of information on pipe network</td>
<td>Systematic maintenance, detection, monitoring &amp; maintenance of old pipes</td>
<td></td>
</tr>
<tr>
<td>Lack of maintenance</td>
<td>Information programs to public &amp; other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standardisation of installation, material &amp; control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pipe data base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Replacement connection policy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate pressure regulation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operational Control</th>
<th>Deficient operation control</th>
<th>Monitoring indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water distribution system automation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Designing operations control units</td>
<td></td>
</tr>
</tbody>
</table>

Source: Urban Water Demand Management in Southern Africa
increased by 80%. Governments should put in place legislation that provide the legal environment to ensure that industrial consumers are maximising their reuse potential. In addition efficient cooling and process modification measures can reduce demand in this sector.

Reduced domestic demand can be achieved by regulation on low-water use plumbing fixtures, repair and replacement and efficient lawn and home garden irrigation. Lawn and home garden consume between 30-50% of all domestic water demand in urban areas. Measures that target all non-interior domestic water demand are needed.

Low-water use plumbing fixtures, repairs and maintenance measures can reduce commercial/institutional demand.

Reduced drought period demand is easier to implement during drought periods. This issue will be accepted, funded and implemented during drought. A demand management strategy that focuses on water saving and public education should be prepared and used.

Most cities in Africa have not seriously embraced the advantages and benefits of Water Demand Management. One of the obstacles in achieving any success in Water Demand Management is the low level of understanding by decision-makers and users about its technical and financial benefits. Without this understanding decision makers will not approve and facilitate Water Demand Management nor will stakeholders be able to accept and assist it.

Policies on Water Demand Management not only have to be established but also supported from the highest levels and with realistic budgets allocated for their enforcement. Water Demand Management requires initial capital investments as well as operation and maintenance budgets. The single most important activity in tackling loss control reduction programme is the need to change attitudes towards operation and maintenance and the institutional acceptance of loss control as an essential normal operation. Water Demand Management also requires trained and committed staff to run it.

The experience of implementing a Water Demand Management strategy had lasting consequences in Bulawayo:

- Water conservation has become part of the ethos of the City.
- This combined with the rising block tariff system has given rise to some of the lowest per capital water consumption figures in the region (high density 36lpcd, low density 75lpcd).
- The Bulawayo Water Conservation and Sectors Services upgrading project introduced new management tools (sophisticated GSP based utility mapping, network modelling, pressure and meter zoning and established water loss control systems) conducted studies to enhance understanding of what needs to be done and made a start on replacing corroded parts of both water and sewerage networks.
- Much of what was done under the project has been embedded in the planning and operations of Bulawayo Water – a lasting legacy.
Bulawayo Water ranks the elements of Water Demand Management as follows:

1. Pressure management (which in turn requires mapping, network modelling, upgrading of Pressure Reducing Valves and Zoning. Reduction of pressure will reduce the rate of leakage).
2. Improved operation and maintenance management system
3. Equitable tariff structure, which is also conservation, oriented.
4. Establishment of a leak detection unit.
5. Asset Management (progressive replacement program)

It is important that water utilities embrace Water Demand Management. There are specific actions to be taken both at the level of the local authority (pressure management, improved maintenance, leak detection and reduction) and at the level of consumers (avoidance of wasteful uses of water, fixing of on-property leaks, use of rain water harvesting, wells and boreholes).

Once the ethos of Water Demand Management takes root, previous demand projections will be found to be exaggerated, supply projects can be delayed and substantial capital expenditure savings will arise.

6. REUSE OF WATER

Where water is a scarce and a valuable commodity, then reuse of properly treated sewage effluent must be carefully considered as one of the prime sources to supplement urban water supplies.

 Appropriately treated recycled water can be reused to reduce the demand on primary resources like surface or ground water. It can be utilised to increase the available supply of water. The use of treated wastewater as a new resource, source substitution or source to augment the existing supply is practised in many places in the world with the aim of servicing an increasing population from any existing water sources.

FACTORS WHICH INFLUENCE THE REUSE OF WATER

Legislation has a major influence on the reuse of water. In many developing countries there is no proper legislation to regulate water pollution leading to pollution of scarce surface water and ground water sources. Due to absence of proper legislation some industries may render water unsuitable for reuse.

Public opinion and the attitude of water managers for or against the different forms of reuse of water can have a major influence. Most of the time there is a psychological and/or a religious barrier against potable reuse, which is difficult or even impossible to overcome.

Water and sewage authorities are separate in some organisations. This makes it difficult to achieve the most efficient use of water as a resource as each organisation would have a different goal. For this reason water and sewage authorities should not be separated. Many water managers regard wastewater as a product that is not suitable for any application within their field of experience.

In many countries water use is under priced or subsidised and the price does not reflect the scarcity of available water. This leads to false economics with the argument that it does not pay to reuse water as it is too expensive in comparison with existing sources, which are sometimes heavily subsidised.
IMPORTANT ISSUES IN WATER REUSE

When engaged in water reuse it is important to keep the following in mind:-

♦ Protection of users is very important, whether it is used for irrigation or any other purpose.
♦ Treatment of reclaimed water to an appropriate quality standard to ensure the proper removal of all disease causing substances.
♦ Soil quality: water used for irrigation should not contain high concentration of chemicals so as to cause salinity of the soil. Long term negative effects cannot be ignored.
♦ Environmental Protection. Reused water should not contain pollutants or significant concentration that may lead to groundwater pollution.
♦ Water quality – the correct water quality for the required purpose should be used. The water quality for restricted irrigation will be different from water used for growing of food eaten raw.
♦ Social aspect – there should be a clear policy framework for reuse of water in a country. This should take religious and social preferences of the population into account.

HEALTH RISK

With indirect reuse of water the health risks are neglected in many cases due to the fact that water managers regard water in a natural stream or catchment as “natural water”. Remember – there are few places in the world with natural unpolluted surface water. Health risks include both microbiological and chemical risks.

There are technics for providing a method of quantitatively assessing human health risks associated with exposure to pathogens in recycled water. The specific application of water for a specific reuse application determines the risk to the population exposure to the water. If water is used to irrigate forests with no access to human beings the health risk may be low. There may be other risks like soil and groundwater pollution.

ENVIRONMENTAL RISKS

Guidelines for the use of recycled water have tended to focus on health protection measures. There is need also to ensure that the impact of recycled water application on soil and ground water are environmentally sustainable for the long term. Factors to be considered in guidelines include salt and chemical content, hydraulic and nutrient loading rates. In each reuse scheme there should be an irrigation management plan prepared to suit the local environmental circumstances.

SOCIAL ACCEPTABILITY

Accepting reuse techniques to make up for the water shortages could provoke negative public reactions. It is important to mount public awareness campaigns so that consumers are well informed and can accept willingly the new supply option. A point has to be made to provide continued public assurance on the quality of reused water.
WATER QUALITY GUIDELINES

These differ from country to country and even amongst different regions in the same country. Water quality guidelines are necessary to give guidance to the different qualities and treatment requirements needed to lower the risk of water reuse. The United States Environmental Protection Agency (EPA) for Water Reuse contains guidelines for a wider range of reuse activities. The World Health Organisation has also published guidelines for water reuse.

Typical guidelines can be found in the following countries and organisations:

Irrigation water

♦ -Food and Agricultural Organisation
♦ -United States Environmental Protection Agency and California guidelines
♦ -Australian
♦ -Israel
♦ -South Africa, Namibia and Zimbabwe

RE-USE APPLICATION IN URBAN CENTRES

Categories of reuse occur in various urban centres in the world as follows:-

♦ Urban agriculture – crops and food
♦ Landscaping irrigation – parks, green belts, sports fields and cemeteries.
♦ Industrial – cooling water, cascading where industries reuse water with various qualities as required for the various processes.
♦ Nurseries
♦ Heavy construction e.g. roads
♦ Recreation and environmental use, lakes, fisheries etc.
♦ Non potable urban reuse in toilet flushing (Japan) car washing, fire fighting and gardening.
♦ Potable reuse – blending with raw water from other sources and direct re-use of water (Windhoek for example). Blending with groundwater through artificial recharge.

INDIRECT REUSE

Indirect reuse of water is the discharge of treated wastewater to the environment in a surface stream for reuse downstream. The treated wastewater may also be discharged in infiltration basins for artificial recharge of an aquifer and for reuse at a later stage.

Advantages of this method of reuse include the following:-

1. Loss of identity – Water that has been used already upstream is really wastewater but it looses its identity when it goes back into the river and reused.
2. Natural Purification – depends on the water course wetlands etc.
3. This is normally the cheapest option
4. Enhances recharge of the underground water
5. Returns flow to stream to retain a base flow for environmental use.
Disadvantages of this form of water reuse are as follows:-

1. Water Treatment – Effluent mixed with water from other sources often requires more intensive water treatment. There is a tendency to ignore this requirement when water is indirectly reused. The problems experienced with algae blooms in Lake Chivero supplying water to Harare is a typical example.
2. Eutrophic Water – Discharge of nutrient rich wastewater causes algae bloom in rivers and water bodies.
3. Evaporation losses from rivers and open dams (reservoirs) can be very high in arid climates.
4. Unplanned or ‘natural water’ – What may be regarded as natural water may actually be wastewater. In some South African Catchment the wastewater component can be as high as 80% during periods of low flow.
5. Salinity increase and low quality water in public streams cause quality deterioration for downstream users including irrigation. In some cases the population down stream of wastewater plant outlets are exposed to water with unknown pollutants including bacteriological and biological pollutants (pathogenic protozoa).
6. Mixed effluent may include industrial pollution.
7. There is no direct control of the effluent returned to the stream from wastewater plants. However in some countries like Zimbabwe, South Africa and Namibia discharge from wastewater is controlled through a permit system.
8. Despite a high percentage of wastewater in raw water supplies, conventional water treatment methods are normally used.
9. Many times additional quality control of the final water is not done because the water is regarded as pure natural water.

The following issues are identified as important factors that need to be taken into account with the indirect use of water:-

a) Indirect reuse is a function of retention time, quality of the raw water and quality of inflow into the river.
b) It is a function of the frequency and the period that people are exposed to the raw water with a high percentage of wastewater origin.
c) There is evidence that in many countries where there is indirect reuse of water there are not enough barriers in the conventional treatment plants to handle the waste water. There is also the problem of algae bloom.

There is also no unplanned reuse. All reuse is planned. As soon as wastewater is put in a stream, it should be monitored that water treatment plants downstream can be adjusted to handle the higher pollution load for public health protection.

Indirect reuse through the return flow (discharge of treated wastewater to public streams) is an important source of water and is controlled through the integrated planning and management of the country’s water sources. Indirect reuse may be one of the cheapest options, contributes to the total availability of water, enhances ground water recharge, provides base flow of water in public streams and makes use of natural purification which occurs in the environment. The loss of identity of the water is also an important benefit.

The biggest drawback to indirect reuse is the loss of water through evaporation in arid parts of some countries, health risks that are encountered where water is collected from surface streams with little or even no dilution in ephemeral streams and deterioration of water quality to downstream users.
Harare, the Capital City of Zimbabwe is located in the catchment of Lake Chivero and Lake Manyame from which water is obtained. Two major sewage treatment works, Firle and Crowborough generating about 220ml/day of treated or partially treated sewage discharge their final effluent that recharges the lakes. This is an indirect reuse.

**DIRECT REUSE**

Direct reuse can be practised through on-site treatment of wastewater and distribution of effluent for consumption. The alternative is to collect all wastewater and to treat it at a central wastewater treatment works to the required quality for distribution and use through a dual pipe system, augmentation of potable supply or direct groundwater recharge.

Advantages of this form of reuse are as follows:-

- Integrated control.
- Pollution control to prevent the dumping of harmful substances in sewers
- Direct control on industrial effluent
- Wastewater quality is controlled to ensure a high quality product
- The users who pay for the treatment of wastewater to be treated to a high quality benefit directly from their investment
- The water treatment plants are designed for reuse. The plants are normally designed for specific requirements related to the end use quality required for a specific reuse application.
- Blending of final water can be done in a controlled way to minimise the risk to users. This is mostly applicable for potable reuse.
- Risk Management can be done in an integrated way.

Disadvantages are as follows:-

- Psychological barriers
- Uncharted territory. In the case of potable reuse there are not many examples elsewhere in the world
- Micro pollutants can be problematic in potable reuse
- New chemicals synthetic organic chemicals can be problematic in both potable and irrigation reuse.
- The presence of medical substances in treated wastewater needs to be addressed in the design of a plant for potable reuse.

In Tokyo the reuse of wastewater after treatment for flushing toilets and for landscaping is practised.

In Phoenix, Arizona main sewers are mined for water to irrigate golf courses. The water is treated before application to an acceptable quality while the sludge is returned to the main sewer for treatment at waste water plants.

In the City of Bulawayo, direct reuse of water is practised at most wastewater treatment plants. At one of the sewage works, Thorngrove, a tertiary treatment system was installed in the 1960s to produce reclaimed water for distribution to public amenities like sports fields and clubs. The distribution of the reclaimed water is through a separate system.
Dual reticulation systems were also installed in Windhoek, Walvis Bay, Swakopmund and Tsumeb – all in Namibia. The water is mainly used for parks, sport fields and cemeteries.

7. ARTIFICIAL RECHARGE SCHEME

The artificial recharge of treated wastewater to augment a limited water resource and to ensure the long term availability of a relatively low cost water supply has been in operation for over 20 years. The geo-hydrological conditions of the basin to be charged have to be known otherwise the underground water could be polluted.

Atlantis, an industrial growth area situated near Cape Town in South Africa, through a multi-disciplinary approach and close co-operation among professional bodies, has achieved a highly cost efficient water resource management scheme that sustains its growth. Atlantis can serve as a prototype for artificial recharge in arid areas of Africa.

The City of Bulawayo has adopted indirect recycling of domestic sewage effluent as part of its future supply strategy. Recent studies have recommended the use of Nyamandlovu, an Aquifer some 40 kilometres to the North of the City, for artificial ground water recharge. Domestic sewage effluent will be conveyed to Nyamandlovu, filtrated into the ground, extracted, treated to potable water standards and distributed in the city. This type of indirect recycling may have a potentially high degree of social acceptability.

Another example of artificial recharge water is the Windhoek Aquifer. The City of Windhoek has the potential to significantly enhance the reliability of its water reserves by applying the concept of water banking by recharging the aquifer with recycled water during the wet season and draining water from the aquifer during periods of drought (Tredoux and Murray, 2000) the value of having an additional amount of water in the City's water bank is quite obvious.

The town of Swakopmund and a Rossing Uranium Mine is supplied with water recharged into the Omdel Aquifer. The recharge into this aquifer occurs during the flood events. Boreholes were drilled in the recharge aquifer from which water is abstracted and pumped into the system. The operation of the scheme is dependant on run-off into the Omdel Dam where the flood waters are stored for long enough for the sediments to settle after which water is released down the river to recharge the aquifer.

The important issues here are soil quality, environmental protection, water quality and social aspects as explained earlier on. The importance of standards that protect the health of the users cannot be over emphasised.

The principles of reuse of water and artificial recharge are acceptable. However, these technics have different levels of acceptability. Water of any quality is increasingly becoming a scarce and an extremely valuable resource to be harnessed in whatever manner permitted by legal, health, social environment, available technology and economic constraints.

Industrial wastes contaminate effluent and diminish significantly its potential for reuse and therefore should be separated from domestic waste. Water reuse and artificial recharge can be successful and economically viable if there is strict monitoring and enforcement of governing regulations and guidelines. Differences of water availability occur between regions. Some countries have plenty of water and others are water stressed, there is therefore a need for a regional co-operative approach in
order to develop unified approaches to managing water resources and avoid potential conflicts in some areas.

Different nations have adopted different guidelines for water reuse and artificial recharge. In these issues it is better “to think globally and act locally”.

The potential for reuse and artificial recharge remains untapped in many African countries for a variety of reasons. In the more arid parts, where droughts and water shortages are prevalent this potential has to be exploited to the benefit of local urban communities. Appropriate infrastructure has to be developed.

With proper care and diligence water of acceptable quality can be consistently produced from domestic waste. If properly informed consumers will fully accept the concept of water reuse and artificial recharge.

Dr Lukas Van Vrwen of Windhoek water pertinently summarised the issues “Water should not be judged by its history but by its quality”.

8.0 PERFORMANCE INDICATORS AND BENCHMARKING

During these days of intense decline in most of the African economies, it is obvious that water providers have to establish systems for evaluation of their activities and to make comparisons with others.

As with all other service providers, the water industry’s objective is to achieve the highest level of consumer satisfaction and service quality within the prevailing regulatory framework and available resources. For a utility to achieve this goal, it needs to measure its performance in the various fields of the business. In their water industry these fields can be brought together into groups.

♦ The provision of an appropriate level of service to consumers.
♦ Obtaining the highest possible productivity from human resources and offer the best employment and other opportunities according to the individuals skills and aptitudes.
♦ The most efficient use of water and other natural resources.
♦ The most efficient use of financial resources.
♦ Planning, constructing, maintaining and operating the physical assets as efficiently and effectively as possible.

Performance indicators are used to measure performance in respect of set objectives, targets and action plans. These are tools for management to set targets in the search for the best practises that lead to superior performance. Their potential as a management tool in the evaluation of operations and investment in the water industry are unquestionable.

Performance indicators should be used selectively. The use of too many is likely to dilute their power. Managers may become confused about priorities and burdened by paper work and overwhelmed by detail. On the other hand the use of too few may not adequately describe the utility’s performance and progress in reaching its goals.

USES FOR PERFORMANCE INDICATORS

Performance indicators in the water industry are of value to water utilities, national and regional policy-making bodies, regulatory agencies, financial bodies, consumers
and stakeholders as well as international organisations. The following are fields where performance indicators can be used.

**Water utilities**

- Facilitates appropriate responses from managers.
- Allows for easier monitoring of the effects of management decisions
- Provides key information for a pro-active approach
- Identify strengths and weaknesses of departments
- Facilitate the implementation of benchmarking
- Provides a sound technical basis for internal auditing and predicting the effect of any recommendations made as a result of an audit.

**National and Regional Policy Making Bodies**

- Provides a common basis for comparing the performance of water undertakings and identify possible corrective measures
- Supports the formulation of policies for the water sector

**Regulatory Bodies**

- Provides key monitoring tools to help safeguard consumer interests in a monopoly service provider situation and monitor compliance with contracted goals.

**Financing Bodies**

- Assists in assessing investment priorities

**Consumers and Stakeholders**

- Provides for the simplifying of complex ideas into simple-to-understand information
- Provides for a measure of the quality of service provided.

**International Organisations**

- Provide for a common language in the water industry to identify the differences between various regions in the world.

**Performance Indicators in the Water Industry**

The International Water Association has developed a set of performance indicators for the water industry. The list of indicators presents those indicators considered as the most relevant for most water utilities, to be used on a routine basis at top management level. Complementary indicators that tend to be more organisation dependant will be needed at departmental level.

The implementation of the complete system may be too demanding for many utilities. Even for those that can afford to allocate the necessary internal resources, a step-by-step implementation may be advisable.

The structure adopted for the indicators derives from the fact that they need to be applicable to undertakings with different internal organisations. Therefore it cannot be based on any particular organisational structure.
The proposed structure reflects the five types of management objectives listed above. These are being considered applicable regardless of the organisational structure.

The structure of the performance indicator framework is as follows:-

**Water Resources Indicators**
- Inefficiency of use of water resources
- Resources availability ratio.

**Personnel Indicators**
- Total personnel
- Personnel per main function
- Technical service personnel per activity
- Personnel qualification
- Personnel training
- Personnel health and safety

**Physical Indicators**
- Treatment
- Storage
- Pumping
- Transmission and distribution network

**Operational Indicators**
- Inspection and maintenance
- Mains, valves and service connection rehabilitation
- Pumps rehabilitation
- Water losses
- Failures
- Metering
- Water quality monitoring

**Quality of Service Indicators**
- Service
- Customer complaints

**Financial Indicators**
- Annual cost
- Annual revenue
- Annual investment
- Average water charges
- Efficiency indicators
- Leverage indicators
- Liquidity indicators
- Profitability indicators
- Water losses

The indicators mentioned above are calculated from data retrieved from the records of the water utility. It is therefore important that the database of the business is structured so as to capture the needed information to calculate the performance indicators on a regular basis.
The International Water Association developed a software package (Sigma Pro) which enables users to define a personalised set of performance indicators. Sigma Pro also allows for benchmarking by comparing data from several undertakings.

The reform of the water sector and the expansion of services to the urban centres has attracted many players. Water Utilities Partnership, WUP, is a joint program of the Union of Africa Water Supplies (UAWS), the Regional Centre For Low Cost Water and Sanitation (CREPA) and the Centre for Training, Research and Networking for Development (TREND) are involved in assisting water utilities to meet the challenges of water supply and sanitation. WUP has initiated a project called Services Providers Performance Indicators and Benchmarking Network Africa (SPBNET). Sharing experiences with WUP will advantage all those interested in these issues.

**BENCHMARKING**

This is the search for industry’s best practice that leads to superior performance. The pursuit of performance improvement and the implementation of best practice are not a one-off exercise. It is a continuous process. The implementation of the best practice is a vital activity. Without the will to change existing practises, benchmarking is a wasted activity.

Africa cities should aim at co-operating to develop performance indicators which make comparisons between the cities possible.

**9.0 PUBLIC PRIVATE PARTNERSHIPS (PPP)**

With the present uncertainty in the economic conditions in the world and the consequent potential reduction in foreign direct investment, the private sector is likely to play a significant role in assisting local authorities to develop their municipal infrastructure and operate these facilities. Developed countries such as the USA, France, UK, Spain, Netherlands etc have been involved in Public Private Partnerships.

African cities find themselves in that position where most of the service infrastructure has outlived its useful life and is starting to collapse. Some cities have successfully engaged the private sector to set up and implement a customer – management and service reinstatement programme. Delegated management of water and sanitation has been engaged in some African countries e.g. Chad, Congo, Gabon, Nigeria. There is therefore some experience that other African countries could draw on.

Delegated management concept in overseas countries was a success because of a combination of professional expertise, committed management, new technology and new financing schemes together with sophisticated long term planning associated with:

1. Laws allowing the participation of the private sector in the Municipal service field and conditions of operation, including specific provisions on tax laws.
2. Contractual formats and institutional frameworks for effective Public Private Partnerships.
3. Quality standards
Within the urban context, delegated management is a concept in which the Urban Council delegates the responsibility of operating and managing a municipal service to a private undertaking or joint venture between parties while retaining the:

1. Ownership of assets
2. Monitoring and control of the services rendered
3. Setting of tariffs to the end user

Specifically, the advantages of Delegated Management include:

♦ The assets of the municipality are not transferred to the specialist company, but only utilised by the company
♦ The specialist company provides additional assets of the municipality as and when required.
♦ The specialist company maintains the assets of the municipality.
♦ Upon the expiry of the contract, the assets (i.e. old, and newly provided), remain with the municipality.
♦ The specialist company must perform against contractual standards set, for quality of water supplied, effluent discharged and service rendered, all of which are monitored by the municipality.
♦ As the improvement of services to required levels is a protracted process, the delegated function normally extends over a minimum of 10 years.

Long term contracts facilitate the specialist company’s commitment to:

♦ Maintaining or improving the community’s quality of life.
♦ Offer the existing municipal employees preferential employment opportunities. Appointment conditions being no less favourable than those enjoyed with the municipality.
♦ Results and quality of service
♦ Staff training and development programmes, those employees who take advantage of these development opportunities are assured of upward accessibility within the company.

Other forms of Public Private Partnerships involving appropriate water supply management in low income countries is the Public Water Company.

The Public Water Company combines the strengths of market and public governance by offering a combination of private management and public ownership. Under this mode of organisation the local authority is the major shareholder.

Table 4 below shows the six basic modes of water supply sector organisation:

<table>
<thead>
<tr>
<th>Water supply sector organisation: six basic modes</th>
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<tbody>
<tr>
<td><strong>Mode of organisation</strong></td>
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<tr>
<td>Direct public/local</td>
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<td>Direct public/Supra-</td>
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<td>Local</td>
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<td>----------------------------------------</td>
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<tr>
<td>Corporatized Utility</td>
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<tr>
<td>Public owned Public limited company</td>
</tr>
<tr>
<td>Delegated private</td>
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<tr>
<td>Direct Private</td>
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Source: EUREAU (1992) and Sector and Utility Management Group data bank

Corporatised utility describes the prevalent management situation in most developing countries.

A graphic presentation of basic modes of organisations in the water sector is shown overleaf.
The public water company allows for consumer influence and autonomy. The consumers have a direct say in the strategic decisions like approval of the annual budget, on investment plan, or a proposal to change the tariff. The public water company is always an autonomous for profit entity. It does not form part of the administrative apparatus of a town or city.

Public Water Companies have been formed in Netherlands, Chile, Greater Santiago area and Philippines. The African cities have not experimented with Public Water Companies. Parastatals have been set up and these operate under delegated public management but lack the Public Limited Status. Consumers have no power over these organisations through representation on the board or as shareholders.

The state level Parastatals have no mechanism for feeding back the consumers interests, wishes and complaints. The boards are usually composed of top civil servants and lack consumer representation.

Secondly, they lack autonomy although investments all over formally embraced this concept, the World Bank evaluating 120 water and sanitation projects carried out between 1967-1987 singles out the autonomy issue as a key reason for the failure of its projects.
Thirdly, the continuance of “government mentality” in some privatised water utilities. Often government line agency is transformed into an autonomous water corporation and the change does not effect the desired improvements in cost recovery, consumer orientation and operational efficiency.

It is contended that the public water company offer a solution to Public Private Partnerships. It gives consumers a clear voice in the utilities strategic decisions. This way helps to solve the accountability problems that produce inferior services. The public water company has the autonomy with regard to capital procurement and cost recovery. A shift to a public water company could work as a cure for the subsidy syndrome afflicting many African towns.

For those who are converted to try the new shift in thinking, political commitment to reform is a vital precondition for a successful transformation.

The shift to public-owned company will inevitably upset vested interests. Sufficient time should be allowed for building commitment to this new mode of operation.

Publicly owned companies will not solve all the problems faced by Urban Managers but they will make the ride both faster and smoother.

References:


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