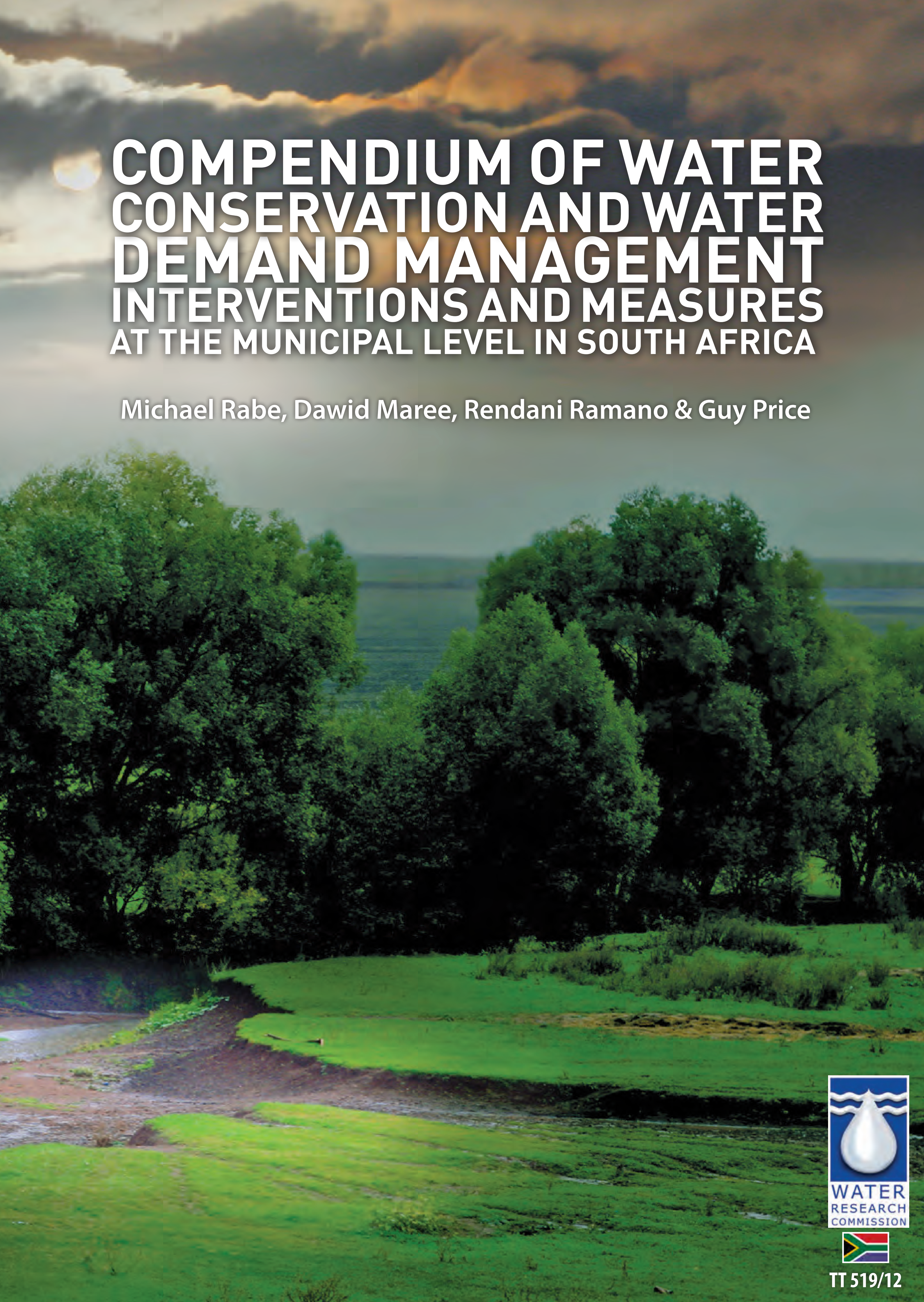
COMPENDIUM OF WATER CONSERVATION AND WATER DEMAND MANAGEMENT INTERVENTIONS AND MEASURES AT THE MUNICIPAL LEVEL IN SOUTH AFRICA

Michael Rabe, Dawid Maree, Rendani Ramano & Guy Price



WATER RESEARCH COMMISSION

TT 519/12

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Water Research Commission
By
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FOREWORD

Water is crucial for the prosperity and growth of any country. This is especially true for South Africa, which as a developing country, faces multiple challenges to water supply. These include pending water stress, growing and urbanizing populations, socio-economic imbalances of the past, widespread poverty, geographically skewed availability and demand, changing weather patterns and persistent drought in many parts of the country.

As a result of the infrastructure intensive supply systems needed at a national, regional and local level to deliver water to end-users, many municipalities across the country are struggling to sustainably meet consumer demand. The dichotomy is that whilst municipalities are struggling to meet demand, water losses are at an all-time high with Non-Revenue water estimates of around 35% of system input volume for the country as a whole. Much of this loss can be attributed to leakage and losses in both the network and on consumer properties which, in many areas, are not unaccounted for and represent a revenue loss to the municipality.

The need for demand-side interventions that effectively reduce physical losses in water networks, artificial demand at the end-user level created through leakage, as well as apparent losses due to metering and billing deficiencies is abundantly clear.

In response to this need, municipalities across the country have initiated interventions, programmes and projects to reduce the demand for water with varying levels of success. Aimed at identifying, documenting and disseminating the experiences of municipalities in water demand management, the Water Research Commission directed the development of this Compendium of Case Studies relating to Water Demand Management at the municipal level in South Africa, presenting 40 case studies in an anecdotal easy-to-read format. The presented case studies highlight not only best practise in the industry, but also less effective approaches that can potentially achieve greater effectiveness through improved management and implementation.

It is the hope of the research team that technical, financial and managerial officials of municipalities, as well as councillors, community leaders and communities themselves, will use this compendium as a tool to identify, conceptualize, formulate and implement initiatives based on case studies presented, that effectively address water demand and reduce water wastage.

Although more than 100 initiatives were identified by the study team during the data collection and consultation phase of the research project, lack of information and documentation reduced the number of case studies that could be included in the compendium to 40. Future revisions may allow for the capturing of additional case studies based on the availability of additional data and experience gained.

Water demand management can be applied in various sectors including mining, power and agriculture. The scope of this compendium was however restricted to water demand management at the municipal level. Our recommendation is that the compendium be broadened in future revisions to include demand-side management by other sectors, other governmental departments, bulk water suppliers and organizations in the water supply chain, as well as by Non-Profit Organizations focusing on demand efficiency in water supply/use.

DEFINITIONS

Climate change – A change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. The United Nations Framework Convention on Climate Change (UNFCC) defines climate change as a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time period, thus making a distinction between climate change attributable to human activities and climate variability attributable to natural causes.

Deemed consumption – The billing of customers in areas where no domestic customer meters have been installed. Consumers are billed on a flat rate according to an average volume of water which the customers are deemed to have used. This deemed volume of water bares little relation to the actual volume of water supplied into these areas by the municipality.

Demand projection – Projections are sets of future conditions, or consequences, based on explicit assumptions. Demand projections estimate the response of the supply system to scenarios, often based upon simulations by applicable models. Projections are therefore subject to substantial uncertainty.

Demand-side management – Any measure, initiative or intervention which may result in a reduction in the expected water usage or water demand of a consumer.

Distribution management – Any function relating to the management, maintenance and operation of any system of structures, pipes, valves, pumps, meters or other associated equipment, including all mains, connection pipes and water installations that are used or intended to be used in connection with the supply of water.

Impact – A beneficial or in most cases, detrimental consequence.

Inefficient use of water – Water used for a specific purpose over and above the accepted and available best practices and benchmarks or water used for a purpose where very little benefit is derived from it.

Integrated Planning – A method of analysing the change in demand and operation of water institutions that evaluates a variety of supply-side and demand-side management measures to determine the optimal way of providing water services.

Integrated Resource Management – A way of analysing the change in demand and operation of water institutions that evaluates a variety of supply-side and demand-side management measures to determine the optimal way of providing water services.

Non-Revenue Water – The total of apparent and real losses plus the proportion of authorised consumption which is not billed.

Retrofitting – The modification, adaptation, or replacement of an existing device, fitting or appliance.

Risk – A situation, or characteristic of a system in which the probabilities that certain states or events will occur (or have occurred in the past) are precisely known. Risk is a combination of the chance or probability of an event occurring, and the impact or consequence of the event, given that it has occurred.

Stakeholder – People, including organisations, who have an investment, financial or otherwise, in the consequences of any decisions taken.

Supply-side management – Any measure or initiative that will increase the capacity of a water resource or water supply system to supply water.

Unaccounted for water – The difference between the measured volume of water put into the supply and distribution system and the total volume of water measured to authorized consumers whose fixed property address appears on the official list of water services authorities.

Urbanization – The physical growth of urban areas resulting from the migration of the population from rural areas into existing urban areas. Effects include change in density, impact on infrastructure and administration services.

Water conservation – The minimization of loss or waste, the preservation, care and protection of water resources and the efficient and effective use of water. **Note: Water conservation is often associated with the curtailment of water use in times of drought when water is in short supply.**

Water Demand Management – The adaptation and implementation of a strategy (policies and initiatives) by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability.

Water efficiency – Improved technologies and practices that deliver equal or better service while using less water.

Water institutions – Water institutions include both Water Management Institutions and Water Services Institutions as defined in the National Water Act and the National Water Services Act respectively.

Water security – The reliable availability, acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risk.

Water wastage – Water lost through leaks or water usage which does not result in any direct benefit to a consumer or user.

ABBREVIATIONS/ACRONYMS

CMA	Catchment Management Agency
D: NR	Directorate: Natural Resources
DMAs	District Management Areas
DWA	Department of Water Affairs
IRM	Integrated Resource Management
IRP	Integrated Resource Planning
IWA	International Water Association
IWRM	Integrated Water Resource Management
JASWIC	Joint Acceptance Scheme for Water Services Installation Components
KPI	Key Performance Indicator
Kℓ	Kilolitre
LG	Local Government
Mℓ	Megalitre
MNF	Minimum Night Flows
MOEs	Municipal Owned Entities
NEMA	National Environmental Management Act
NGO	Non-governmental Organization
NRW	Non-Revenue Water
NSF	National Strategic Framework for Water Services
NWRS	National Water Resources Strategy
PRV	Pressure Reducing Valve
SIV	System Input Volume
SLA	Service Level Agreement
UFW	Unaccounted for water
WC	Water Conservation
WC/WDM	Water Conservation and Water Demand Management
WDM	Water Demand Management
WELS	Water Efficiency Labelling Standards programme
WSA	Water Services Authorities
WSP	Water Services Provider
WSDP	Water Services Development Plans
WSI	Water Services Institutions
WTW	Water Treatment Works
WWTW	Wastewater Treatment Works

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CONTENTS

INTRODUCTION

1.1 Background

The world's freshwater supply faces challenges relating to quality, quantity and potential conflict over shared international water resources. Increased population growth together with economic development, urbanisation and industrialisation are resulting not only in increased demand but an increase in return flows, pollution loads and solid waste, placing ever increasing pressure on our limited freshwater resources.

1.2 Need for Water Demand Management

As the demand continues to increase against a backdrop of limited water resources, higher pollution loads and at an ever increasing cost to the user, the management of municipal water supply, by authorities throughout the world, is increasingly focusing on water use efficiency, water loss and water demand management.

Water Conservation and Water Demand Management (WC/WDM) offer a viable option to create required efficiencies amongst existing users, whilst ensuring that there is capacity for new water users. Where there is a limited supply of available surface water WC/WDM represents an effective strategy for creating efficiencies, using the resource more effectively, as well as avoiding water wastage and water loss. This then allows for the extension of supply to new consumers.

1.3 South African Context

In South Africa the challenge of ensuring a sustainable water supply is exacerbated by:

- An unusually dry climate with precipitation levels that are lower than the average for many other developed and developing countries,
- A rapidly urbanising population,
- High evaporation levels,
- Skewed development and economic centres that are far from water resources,
- An ageing water supply infrastructure,
- A focus on expansion of the water distribution network at the sacrifice of improved bulk treatment and pumping infrastructure:
- Increasingly intermittent electricity supply affecting critical infrastructure components,
- Improving socio-economic well-being of a large segment of the population which has led to an increase in water consumption,
- A loss of technical capacity and expertise at all levels of government, and
- Extension of supply to the un-serviced urban poor.

1.4 Solution

A possible solution therefore to these difficulties is a WC/WDM approach that addresses the:

- Efficient use of water whereby more "work" is done with the same amount of water,
- Institutional use of water and efficiency thereof,
- Wasteful use of water, whereby wastage is reduced or halted,
- Loss of water, in that water lost in the supply is limited or stopped, and
- Re-use and recycling of water.

WC/WDM can lead to a reduction in the volume of water used and a lowering of the cost to supply water, because of savings in bulk water purchases. Furthermore, when less water is lost in the system the percentage of Non-Revenue Water (NRW) decreases increasing overall cost recovery.

WC/WDM also can lead to a lowering of the impact of water-related anthropogenic activity on the environment. Less water is abstracted from the natural water resources and return flows are smaller. Furthermore, a comprehensive WC/WDM strategy also represents the reduction of water used in certain processes to "clean" either equipment or product. Also, many wastewater treatment works, especially in South Africa, are hydraulically overloaded. With a smaller hydraulic load (albeit with the same waste load) treatment is more effective as the waste load tends to be more concentrated, is more cost effective to treat, and the retention time within the treatment works is longer. This can lead to the improved efficiency in the removal of especially the organic load.

1.5 Lack of Implementation

Although WC/WDM interventions have the potential to address water shortages and keep the cost of water supply down, they are often not considered to be a viable option by water managers in the urban sector throughout South Africa. Reasons for this could include:

- Lack of knowledge of existing alternative interventions to water supply challenges other than just treating and pumping more water,
- Lack of understanding relating to the tremendous advantages of WC/WDM,
- Need for paradigm shift by water managers from traditional water supply interventions to considering WC/WDM interventions as a viable option,
- Misconceptions or a lack of understanding of the cost of implementing WC/WDM interventions,
- Misrepresentation of the success of WC/WDM interventions because of interventions that have failed, due to poor implementation or a lack of social or political support,
- Lack of motivation to justify WC/WDM actions to be taken,
- Lack of financial expertise and understanding,
- Poor management of water supply,
- Lack of baseline water supply information against which savings can be measured and realized and hence then a poor perception of the tremendous opportunity to implement WC/WDM interventions,
- Lack of understanding of the importance of or knowledge of how to implement monitoring and ring-fencing, and
- The wrong or misguided focus of water supply budget and project management.

1.6 Project Objective

The overall aim of this project has been to produce a compendium of WC/WDM case studies highlighting alternative available options to ensure a sustainable water supply by municipalities as compared to only addressing augmentation interventions in order to address water supply.

1.7 Main Project Deliverable

The main deliverable for this project was stated as,

Draft a compendium of up to 40 case studies of WC/WDM interventions as implemented in the municipal water sector throughout South Africa.

Secondary or sub-deliverables stated were to disseminate the compendium of case studies on the WRC web site and the distribution of the compendium. Subsequent to the submission and approval of this report to the WRC:

- The compendium of case studies will be printed and published as a WRC copyrighted publication and disseminated to municipalities across the country, and
- The WRC will arrange the placing of the Compendium of Case Studies on their web-site.

1.8 Methodology and Approach

The basic approach followed was to identify WC/WDM interventions within the municipal water supply sector, then, where possible, interview municipal officials, followed-up with as much research on the project as possible.

A set of selection criteria, listed below, was set in order to discern which case studies should be prioritised for further research as follows:

- Extent of Success: Focus was given to projects that have achieved water savings. Projects that have had a lot of energy and synergy and then have failed could be considered to understand why the project failed, but interventions that did not even get off the ground were not considered,
- Availability of information: The extent of and availability of information was an important part of selecting and compiling a case study,
- Access to information: The granting of permission to access the information,
- Intervention Focus Area Representativity: A spread of a variety and representation of interventions documented as case studies across the different types of focus areas within the water supply sector,
- Diversity of the Case Study: The diversity to the same type of Intervention, and
- Innovativity of Intervention: Interventions that have viewed or found unique approaches to addressing WC/WDM.

A set of actions were planned and implemented. These actions included:

- Listing of all the potential types of WC/WDM interventions that could be implemented,
- Listing of municipalities, including metros, which could be contacted and visited,
- Compiling and using of a questionnaire when interviewing municipal officials face to face,
- Developing and designing of a basic format and outline (template) for documenting the shortlisted Case Studies,
- Identifying WC/WDM interventions that have been successful and can be documented as case studies, and that are representative of the list of WC/WDM interventions identified, municipalities identified and within different types of municipalities in different parts of the country, and
- The drafting of the case studies.

Types of interventions identified to potentially include in the compendium were:

- Financial, and pricing strategies,
- Non-Revenue Water strategies
- Metering, including prepaid metering,
- Logging of consumption,
- Bulk line repairs,
- Leak repairs,
- Pressure management,
- Network repairs,
- Marketing and awareness campaigns,
- Commercial and small industries set within or in conjunction with urban areas,
- Communication and awareness,
- Home and garden water efficiencies,
- Rain harvesting,

- Reuse,
- Recycling,
- Punitive and incentive driven by-laws,
- Standards and by-laws – plumbing materials and workmanship,
- Technology innovations,
- Legal aspects,
- Water quality,
- Illegal connections, and
- Management of storage facilities.

The aim was to contact as many municipalities as possible, including Metros, Local and District municipalities. Contact was initially telephonically and depending on the response, followed up with a set of questions to determine what WC/WDM interventions have been implemented by the municipality. If potential case studies were identified, a face-to-face interview with staff of the municipality was arranged and conducted so as to obtain as much information as possible and so as to gain an understanding of the implemented intervention. Close on 30 municipalities were consulted as part of this process. Follow-up visits were, in some cases, necessary.

A total of around 110 potential case studies were identified during this process. About 50 of these were shortlisted and researched further for possible inclusion into the compendium.

The shortlisting of the identified case studies were based on the following criteria:
- Success of the WC/WDM implementation,
- Sustained water savings and efficiency,
- Availability of information (social/political, technical and financial),
- Existence of a baseline,
- Verification of measurement protocol,
- Innovation,
- Cost benefit,
- Representativity of the intervention within the WC/WDM sector,
- Diversity of WC/WDM interventions,
- Replicability and scalability.

Based on the criteria, discussed above, and especially of the availability of qualitative and quantitative information, 40 case studies have been drafted and included in the compendium.

1.9 Presentation of Case Studies

In order to allow for easy referencing and improve the readability of the compendium, case studies have been categorised into the following broadly defined sections,
- Technical Interventions,
- Financial Interventions,
- Institutional Measures, and
- Behavioural Change.

Some case studies document projects that incorporate a multi-faceted approach to implementation including components in a number of listed categories. In such instances the case study has been categorised based on the department within the municipality most responsible for implementation.

TECHNICAL INTERVENTIONS

Although water demand management cannot be viewed purely as a technical function due to the cross-cutting nature of municipal service delivery that includes financial management, institutional arrangements, community involvement, and policy, it remains at its core a technical exercise. This can best be explained in terms of the extensive infrastructure required to deliver the physical element of water in large quantities to thousands of consumers through an extensive network consisting of primary and secondary pipes, storage reservoirs, water towers, pump-stations, customer connection pipes and water meters, as well as piping and plumbing on properties beyond the meter. It is appropriate therefore that the technical staff of municipalities should 'own' water demand management and initiate solutions that can reduce demand and losses.

The largest majority of case studies documented in this compendium are technically orientated interventions implemented by technical departments of the municipality, aimed at providing a technical type solution to the problem at hand (which may or may not be technical in nature).

Technical case studies have been 'clustered' into categories that are aligned to the different components/ operations of the water supply system, namely:

- Infrastructure,
- Pressure management,
- On-property leak repairs,
- Water reuse, and
- End-user metering

Due to many shortcomings relating to metering, billing and payment for services delivered, water demand management at the municipal level in South Africa must of necessity include interventions beyond the metering point, or on privately owned domestic properties. Indeed the experience of many municipalities is that the largest volume of water being lost or wasted occurs on privately owned properties in especially low-income areas. This can be attributed to the lack of ownership of consumption and plumbing on these properties by same owners. For this reason case studies relating to on-property leak repairs and the retrofitting of plumbing fixtures have been included in the compendium. These types of projects have become fairly common across the country and for the most part are highly successful in reducing water losses, water leakage and the wasteful use of water.

T01

NELSON MANDELA BAY METROPOLITAN MUNICIPALITY

WATER LOSS PROGRAMME

Intervention Type	Identify water losses
Reason	Reduce Non-Revenue Water and water wastage
Cost	R15 million

The Nelson Mandela Bay Municipality (NMBM) embarked on a large scale Water Conservation and Water Demand Management (WC/WDM) programme in 2009. The objective has been to reduce Non-Revenue Water (NRW) by 15% within the next ten years. However, the severity of the recent drought in the Eastern Cape, has forced the Municipality to intensify the reduction of NRW and water wastage.

Reason for Intervention

The NMBM's abstraction volumes have for a number of years exceeded the available water from its local water resources and its allocation from the Lower Sundays River Government Water Scheme.

"Water loss from a water distribution system is a significant factor affecting water delivery to customers."

- Georgia Environmental Protection Division Guidance Document

Figure 1 shows the significant fluctuation of the levels of water in the NMBM's supply dam over a period of 42 months highlighting the importance of an effective Water Resource and Water Demand Management programme. The NRW for the municipality has also increased annually since the formation of the NMBM and is attributed to a number of reasons including:

- Lack of education and awareness regarding water conservation amongst consumers, including the youth,
- Ageing water supply infrastructure,
- Water losses from leaking water meters and on-property leakage in low income residential areas,
- The NMBM not able to put in place the institutional structures to capacitate and successfully deploy a WC/WDM division, and
- A large number of un-metered consumers who are not on the billing system.

Objectives

The primary objectives of the project were to:

- Reduce NRW by 15% within 10 years,
- Reduce water wastage, and
- Improve the sustainability of the water and sanitation services.

Description

The NMBM started by addressing their WC/WDM needs by developing an Integrated Water Resource Management (IWRM) methodology to be implemented over the next 10 years.

A service provider, specializing in systems to analysis water supply and sewer distribution networks, were then appointed to assist in the reduction and control of NRW, with an emphasis on the reduction of "real losses."

The WC/WDM methodology as now developed included:

- Distinguishing and the establishment of water supply zones,
- Preliminary water balances for the different zones,
- Prioritisation of zones with high water losses,
- The analysis of maintenance of work completed,
- Identification of zones or areas where a pressure

management intervention can be implemented,
- The measuring and evaluation of minimum night flows (MNF),
- Network analysis/zone calibration, and
- A phase for completion and zone commissioning.

The NMBM water supply network was then first sectorised into approximately 210 zones using a GIS based engineering information system.

This initiated the Water Loss Programme which was to assess all components of the NMBM's water supply network. Dedicated teams worked through each of the established zones identifying and recording "real" points of water losses on the network.

In the domestic areas the field work included detailed investigations of the water supply infrastructure by inspecting and recording the findings of:
- Valve and fire hydrant infrastructure, as well as updating as-built drawings which is part of the recording process,
- Auditing of the meters,
- Leak detection (visual and sounding), and
- Zone verification by logging and analysing the data of the pressures and flows in the water supply network and the MNF (MNF is the flow in the network during the early hours of the morning when the water supply is expected, in theory, to be zero. The MNF is therefore representative of water leaks in a water supply zone).

Further, part of the water loss programme is the auditing of the Industrial, Commercial and Institutional (ICI) consumers':
- Valve and fire hydrants,
- Meters,
- Water losses through leak detection (visual and sounding), and
- Updating of as-built drawings.

A comprehensive education and awareness campaign which has made extensive use of the media including newspapers, billboards, advertisements and radio has also been carried out by the municipality to compliment the technical interventions.

Results

Approximately 68 000 properties, out of a total of 210 000, have been targeted to date as part of the Water Loss Services Programme. The results for a large residential area (Table 1 below) provide an example of the type of leaks and faults identified.

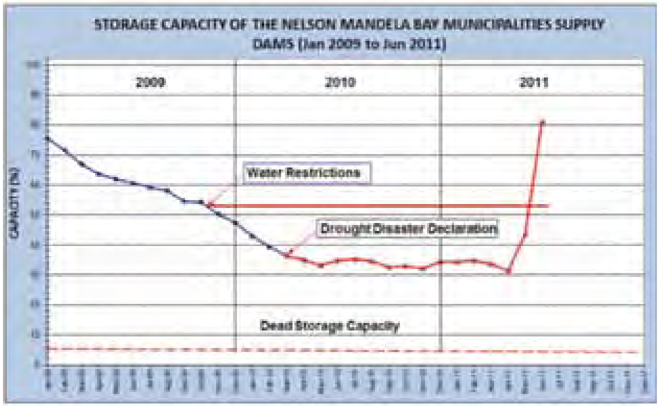

Figure 1: Storage capacity of Nelson Mandela Bay Municipal Dams (2009 to 2011)

Work instructions were then issued to various contractors appointed by NMBM to undertake repairs. Urgent repairs such as large pipe bursts are prioritised in order to minimise water losses.

The following remedial work has been completed for the residential areas investigated to date:
- Community-based semi-skilled plumbers were appointed and trained to carry out leak repairs and install volume control meters for registered indigent consumers with leaking plumbing infrastructure (pipework, fittings, taps and toilet cisterns). With toilet leaks, the cistern is replaced with a siphonic type mechanism,

Table 1: Summary of Faults for a Residential Area

Description	No. of	% of Total
Total Stands	29 789	41.8
Meter Leaks/Faults	5170	17.4
Connection Leaks	115	0.4
Internal Leaks	7144	24.0

- Leaking and faulty meters (most severe in more recently developed low income areas) are repaired or replaced by contractors working under the NMBM Water Installation Workshop,
- Un-metered properties and community stand pipes have been metered and the necessary updates made on the billing system,

- Valve and fire hydrant faults (not shown on drawing, incorrectly shown on a drawing, no cover or manhole, missing marker, not working) have been corrected by contractors and updated on as-built drawings where applicable, and
- Large leaks or pipe bursts are repaired by NMBM (typically within 24 hours).

The results for an industrial area (Table 2) provide an example of the type of meter issues that have been identified for action as a result of the Water Loss Services Programme.

The following work has been completed in response to the audit completed for ICI consumers targeted to date:

- Un-metered fire connections found mostly in older industrial and commercial areas have been identified and NMBM have installed meters,

Figure 2: Burst Pipe located during investigation in residential area

- Industrial and commercial consumers illegally tapping water from fire hydrants have been identified, the connections have been removed and legal action taken where appropriate,
- Valve and fire hydrant faults have been corrected by contractors and updated on as-built drawings where applicable, and
- The following meter replacement or installations have been made by NMBM based on recommendations from the water loss programme for:
    - o Faulty/broken meters,
    - o Inaccurate/old meters,
    - o Incorrectly sized meters,
    - o Incorrect type of meters, and
    - o Poorly installed meters.

Table 2: Summary of Faults for an Industrial Area

Description	No. of	% of Total
Total Stands	136	15.5
Unmetered Fire Connections	8	5.9
Unmetered Properties	2	1.5
Meter Faults	11	8.1

Figure 3: Leaking valve located on bulk supply pipeline

The records of the consumers have also been updated to reflect the above changes. The ICI consumers account for a significant portion of the water use in NMBM. The benefit of this portion of the Water Programme in reducing NRW has therefore been significant.

The NMBM have also identified various initiatives including projects co-funded by the private sector to combat high water wastage at schools.

Figure 2 illustrates the average daily consumption for the month for the Municipality for the past 42 months. Water restrictions, seasonal demands, as well as the WC/WDM initiatives and the media campaign during the programme have had a noticeable impact over this period as illustrated in the graph.

A total of 40 jobs have been created as a result of the Municipality implementing the Water Loss Service Programme. A conscious effort has also been made to build capacity to ensure that the skills developed during the programme can be used by the municipality going forward.

Figure 4: Example of old/non-functioning water meter identified for replacement

Lessons Learnt

- To isolate (or make discrete) water supply zones was often a problem due to faulty valves between or to zones,
- Some zones cannot be operated according to the design criteria for the network due to low pressures resulting from the excessive head losses in the supply network associated with the abnormally high water losses,
- Poorly installed and leaking plumbing fixtures on houses which have recently had solar geysers installed,
- Water losses and wastage as a result of damage to the water supply network by contractors responsible for the installation of bulk services (roads and stormwater),
- No access to certain residential areas due to political interference and infighting,
- Delays in completing repairs due to material shortages and contractual disputes with the municipality (repair contractor),
- Low income houses which are not categorized as indigent with high levels of on-site leakage because the residents cannot afford to or not able to make repairs,
- Finally, the identification of additional leaks after initial plumbing repairs because the systems overall pressure has increased as the bigger and more visible leaks have been repaired.

The importance and significance of the municipality implementing an IWRM approach, that included a comprehensive WC/WDM Strategy, was highlighted by the extended drought recently experienced in the region.

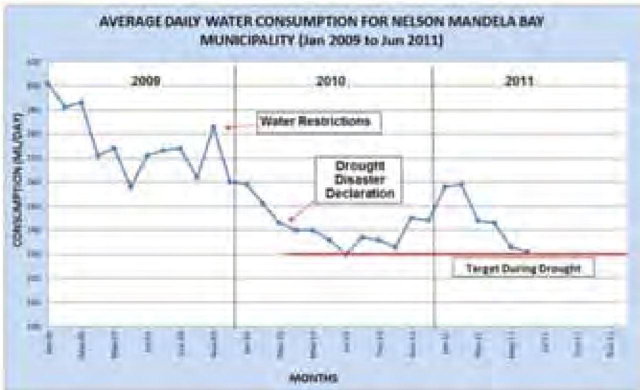

Figure 5: Average daily water consumption for Nelson Mandela Bay Municipality (Jan 2009-June 2011)

Project Highlights:

- ☑ Verified Savings
- ☑ Behavioural Change
- ☑ Political Endorsement
- ☑ Capacity Built
- ☑ High Level Management
- ☑ Cost Effectiveness
- ☑ Replicability
- ☑ Scalability
- ☑ Employment Opportunity

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T02

e THEKWINI METROPOLITAN MUNICIPALITY

DECENTRALISED WATERWASTE TREATMENT SYSTEMS

Intervention Type	Water services infrastructure
Reason	Pilot project to determine if treated wastewater could be used for agriculture

The eThekwini Municipality (eThekwini) covers 2 300 km^2 (0.2%) of the 1.22 million km^2 of South Africa and is home to 3.5 million (7.2%) of the 48.5 million South Africans. Yet up to one million (28%) of eThekwini's residents live in the 415 informal settlements located throughout the municipal area. In 2011 eThekwini was acknowledged by the United Nations with a "Water for Life" award presented by the UN Secretary General Ban Ki Moon acknowledging the city's efforts in improving sanitation. Better sanitation levels leads to the elevation of the general living conditions of the indigent as well as the conservation of water. The main objective of the Decentralised Wastewater Treatment Systems/ Solutions (DEWATS) is to improve sanitation services in areas where there are no water and or sewage facilities.

"The mission of BORDA is to improve the living conditions of disadvantaged communities and to keep the environment intact through the expansion of Basic Needs Services in the areas of decentralised sanitation, water and energy supply as well as wastewater and solid waste disposal."

Reasons

The main focus of the DEWATS project is to improve the general health of indigent people through encouraging a change in the behaviour and as a result a change in the way that they conduct their health related practices. Other benefits of the DEWATS intervention includes the efficient use of water by managing the supply of water and conserving water through the use of treated wastewater for the irrigation of small gardens.

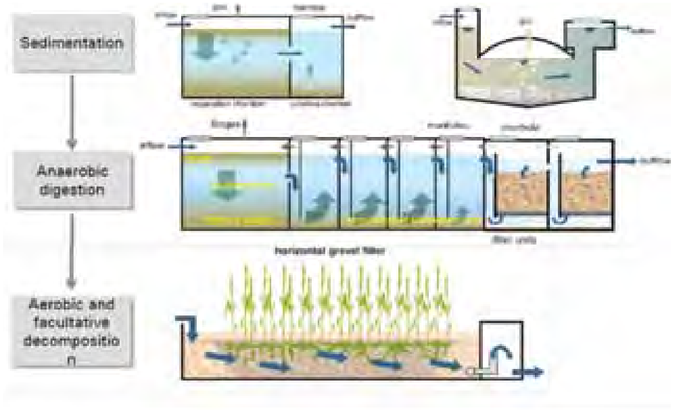

Figure 1: Basic concept of the DEWATS processes

Objectives

The first DEWATS plant (Schematic illustration in Figure 1) was installed at the Newlands-Mashu perma-culture centre in Durban, as a pilot-project in terms of an agreement with BORDA.

The objective of the pilot-project was to substantiate the extent to which a DEWATS unit could benefit an indigent community through the collection and re-use of sewage for gardens. DEWATS is a "flushing toilet" system which is healthier and cleaner than a pit latrine. The vision was that the DEWATS system could be used in dense informal settlements for the collection and treatment of wastewater where connections to the formal sewer network were not possible in the short to medium term.

Description

DEWATS is an improvement to the sanitation system when compared to pit latrines or chemical toilets. DEWATS is an intermediate step towards implementing a fully conventional sanitation system. DEWATS provides a small sewer network which produces biogas that can be used as an energy source and an effluent which can be used as water, with nutrients, for irrigation.

Although the DEWATS unit has to be carefully managed, it gives an indigent community additional options, in a controlled environment, to produce food.

A single DEWATS unit treats 40 kℓ/day of wastewater from 80 households. The treatment process includes a biogas settler, an anaerobic baffled reactor, which cleans the wastewater, anaerobic filters, and constructed vertical and horizontal flow wetlands ensuring that the water quality is fit for the use in a garden. The biogas settler turns organic matter into biogas which is an alternative source of energy. The treated wastewater is rich in nitrogen and phosphorous compounds which provides the needed nutrients for gardens.

Achievements

An installed DEWATS unit in a densely populated informal settlement has the following impacts:

1. Reduces the size, complexities and costs of a fully constructed sewer network system.

The DEWATS unit only requires a small sewer network for a small number of houses. The houses do not have to be connected to a secondary and then the main sewer system all discharging to the main Wastewater Treatment Works (WWTW). DEWATS thus has the potential to eradicate the need for a main sewer network for isolated urban areas.

Figure 2: Informal Settlement without access to basic sanitation

This reduces the need for and costs of installing the main sewer pipeline, which often has to be buried deep to maintain the gravity flow, and the need for pump stations. This further reduces the related impacts on the environment of sewage pollution and the costs related to building and upgrading WWTWs.

2. Time Horizons for the Implementation of Services

The time needed to plan, budget and build a DEWATS unit is "years" shorter than the period before a conventional sewer system is constructed in an urban area. Yet, DEWATS has most of the advantages of a conventional system, at a considerable reduced cost, with immediate implementation in urban areas with poor service levels, and simpler installation of the system. DEWATS is simpler, can focus on the area of concern and is therefore quicker to install and render functional. DEWATS is also independent of a major sewer network construction and or sewage treatment works construction or upgrade.

3. Energy from Biogas

DEWATS caters for generating energy from the collection of biogas reducing the energy consumption of the residents by giving them an alternative form of energy. This will also have the added impact of reducing carbon emissions and methane gases.

4. Water and Nutrients

DEWATS generates water and nutrients that can be used for the irrigation of gardens. Water that is supplied to the community can be re-used and not lost to the sea when discharged directly to the river or through a WWTW, which is especially important for coastal settlements making it an important water efficiency and water conservation project. Wastewater which in most indigent un-serviced communities, that would have been flowing through the streets increasing the instances of water borne related diseases, is also significantly reduced improving living conditions.

5. Upgradability and Size of DEWATS

Anything between 40 and 2 000 households can be connected to a single DEWATS unit. This gives the system practicability of servicing various sizes of communities or areas of communities depending on location and position of the houses without increasing the costs and practicality of managing numerous units.

6. Improved Living Conditions

There are Improved living conditions through improved hygienic conditions due to improved sanitation systems, the availability and use of ablution blocks, controlled water consumption reducing water wastage and reducing the extent or occurrences of wastewater flowing in streets and stagnant water pools attracting pests, mosquitoes, water borne related diseases, etc.

7. Employment and Labour Opportunities

It generates opportunities for employment and helping communities take responsibility for their own water systems and the economic opportunities that come with growing gardens.

8. Water Conservation

Water conservation is improved through training, community education, controlled dispensing points (less illegal connections) and through metering of the water supplied to the DEWATS units. This reduces the water wasted as a result of illegal connections and water losses are identified sooner and rectified over shorter intervals.

Lessons Learnt

The South African government and communities have a perception that only a "traditional" flushing sewer system is an acceptable form of service and that other alternatives means that the community is being "cheated" of proper services.

Cost implications, budget restrictions, aging infrastructure and poor implementation of traditional systems are leading to an ever increasing back-log of functional sanitations systems.

DEWATS is economically, practically and environmentally viable, and can be installed in areas where sewer connections will not be available for the foreseeable future.

Figure 3: Permaculture in the area

DEWATS units can be planned, built and in operation within a period of 12 months which is significantly shorter than it would take to put in a conventional sewage network.

The "service" delivered is "acceptable" and comparable to a "traditional" flushing water borne system.

Partnering and co-management with communities and private parties with the reality of corruption levels as they are is a concern and the implementation of DEWATS is open to abuse. However, sanitation systems need to be put in place, jobs need to be created and communities need long-term sustainable options to generate additional income. DEWATS is an opportunity to uplift an indigent community and municipalities need to conceptualise and realise the opportunities that DEWATS presents for a municipality to implement services quickly and effectively.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [ ] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T03

CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY

ACTIVE LEAK CONTROL

Intervention Type	Leak detection and repair
Reason	Reduction of real or physical water losses associated with underground water supply networks
Cost	Unknown

a world class African city

In recent years, Johannesburg Water (JW) has experienced an increase in real or physical water losses. These losses are associated with the distribution network and are indicative of the age, condition and operating regime (pressure, surge, flow, etc.) in which water services are delivered by the utility to consumers.

The increasing level of physical losses in Johannesburg is reflective of an ageing network across most parts of the city. Over time, it will be necessary for JW to replace large parts of the existing water network and, especially, networks consisting of Asbestos Cement (AC) pipes. This type of pipe material is prone to leaching of cement from the pipe wall over time, making the pipes brittle and resulting in pipe bursts and failure. Replacement of networks is an expensive exercise and thus highly dependent on available capital and hence then also the competing needs of the utility/city.

"We take clean water blissfully for granted, because it's always so abundantky available to us."

- Pure Inside Out

Active Leak Control

As an alternative interim measure to the outright replacement of networks, Active Leak Control (ALC) can easily be implemented by a utility as an on-going programme to detect and repair both visible and invisible leaks. In contrast to Passive Leak Control (PLC) which relies on the general public to report leaks and bursts through a centralised call centre operation, ALC is a programme whereby pipeline 'routes' (or the surface position of underground pipes) are 'walked' regularly with a view to identifying visible leaks. These inspections can also include the use of leak detection equipment in the form of listening sticks and/or correlators which can also help locate invisible leaks.

Figure 1: Physically walking a pipeline route to detect leaks using leak detection equipment

Commencing in 2008, JW has implemented an Active Leak Control programme, in terms of which approximately 70% of the total water network consisting of more than 10 000 km of pipeline is physically walked and inspected once a year to identify visible leaks and faults (including the use of leak detection equipment as and where appropriate). Logged leaks and faults are reported back to dedicated operational staff (plumbers, artisans and general workers) in each region or depot for repairs. This exercise includes inspecting each consumer meter, network valve and fire hydrant for leaks and faults.

In each operational region, a number of ALC teams consisting of a supervisor, 3 operators and 3 assistants have been appointed to the ALC programme. These teams have been specially trained and capacitated to complete this specialist task. Within each operational region, a Special Services Department has been set up with dedicated teams responding to the reported faults and potential leaks.

Teams move from suburb to suburb, aligning inspections to actual water supply or pressure zones. Where necessary, more detailed investigations are undertaken, using leak detection equipment (amplified listening sticks, leak noise loggers and correlators) and data logging results to locate leaking pipes, valves and hydrants. For zones that have been designed, ring-fenced and made discrete, discreteness is confirmed by performing zero pressure tests across zone boundaries and checking for water pressure readings in any part of the network.

Figure 2: Extensive excavations undertaken in the Sandton area to expose and trace the position of a leak from an underground pipe

The initiative also involves the logging of pressure and Minimum Night Flows (MNF) using in-house data loggers. The purpose of this exercise is to identify areas or zones with higher levels of leakage. Additionally where it is merited, intensive investigations are undertaken to try and resolve specific leakage problems where the cause or origin is not immediately apparent. This could include investigating seepage on the surface, continuously running water in stormwater drains and pipes, as well as 'wet' areas where the cause may be a leaking underground pipe.

Often extensive excavations are required to expose underground pipes and trace the leaking water back to the broken pipe as shown in Figure 2.

Objectives

The main objective of this ongoing programme of JW is the reduction of real losses associated with the water network including pipe bursts, leaking valves, leaking hydrants and leaking/broken water meters.

Goals

Because this project has been highly successful in reducing leakage from the water network, Johannesburg Water is aiming to increase the length of water mains covered per year throughout the city from 70% to 80% of the total water network.

Challenges and lessons learnt

Officials of JW who were interviewed expressed the need for additional human resources and capacity to improve the success of this initiative. Also expressed was the need for specialised training on the use of some of the logging and leak detection equipment as well as the upgrading of certain items such as the amplified listening sticks.

Various problems were highlighted and specifically the lack of maintenance of Pressure Reducing Valves or PRVs (both proactive and reactive maintenance) in the water network. Failure to maintain specialised equipment such as electronic PRV controllers has meant that they need to be removed and returned to the suppliers for repair. This has had a negative impact on water savings achieved through the ALC programme as pressure cannot be regulated over time whilst the controllers are in for repairs.

Figure 3: Underground leak identified by ALC team

Achievements

According to Johannesburg Water, an 80% success rate in terms of repairs of faults reported on by the ALC teams has been achieved. This has been attributed to good communication between the repair crews and the ALC teams, directly as a result of the dedicated ALC teams operating out of actual depots and satellite offices and reporting to Depot Management.

Another key factor is that all faults are logged onto the Operations Management System, assigned a Job Number with a Job Card allocated to either a plumber, artisan or Special Services Team for repair.

The repair team is required to report back to the Management System on completion of the task. All feedback is collated and reported on to the JW NRW Operations Manager.

Although it is difficult to quantify the reduction in physical losses that have been realized through this initiative, JW staff are in general agreement that the programme has been successful in better managing bursts and reducing water losses. As a result, JW has committed to increasing the total length of mains covered per annum by the ALC teams from the current 70% to 80% of the water network.

Similar Case Studies

Other municipalities in South Africa that have implemented ALC include:

- Nelson Mandela Bay Metropolitan Municipality – Water Loss Programme,
- Ekurhuleni Metropolitan Municipality – Reduction of Non-Revenue Water, and
- Mogale City Local Municipality – Water Demand Management Programme.

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T04

CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY

SOWETO INFRASTRUCTURE UPGRADE PROGRAMME

Intervention Type	Infrastructure upgrade, metering and leak repair
Reason	High level of water losses in both the network and on properties
Cost	R1.2 billion

Johannesburg Water

During the early 2000s the supply of water to Soweto was characterized by unsustainably high wastage. Prior to intervention by Johannesburg Water (JW), water supplied to the greater Soweto region averaged close on 70 kℓ per property per month with the total supply volume increasing at 4% per annum. Given the culture of non-payment which was prevalent at the time, the supply to Soweto represented an enormous unsustainable financial loss to both the municipality and JW.

In response JW formulated a multi-faceted intervention project including the renewing and relocating of the decrepit water network, repair of leaks on private properties and the installation of prepayment water meters.

In areas where the project has been completed, the average supply per property has dropped to 10 kℓ per property per month, demonstrating the success of the interventions in eliminating water wastage and reducing Non-Revenue Water (NRW). This is even more significant given that the Free Basic Water volume is 6 kℓ per property per month.

> "South Africa needs urgent investment of some R100 billion in bulk water infrastructure and reticulation..."
>
> *- Water Rhapsody*

The Soweto scenario prior to intervention is representative of many former township areas throughout South Africa, and highlights sustainability and environmental concerns that South Africa should be addressing, especially since the country is classified as water scarce.

Background

Investigations completed by JW showed that the high volumes of supply and associated water wastage in Soweto could be attributed to a number of factors including the 'deemed consumption' billing method for water services, a lack of maintenance of private plumbing fixtures by property owners, as well as the poor condition of the water network.

Many of these issues were rooted in the previous political dispensation of the country and required redressing through a holistic approach that included technical and financial solutions as well as technologies that could bring about a much-needed behavioural change.

The 'deemed consumption' billing method which had been implemented by the city across Soweto was of particular concern. Because of the lack of domestic meters, households are billed a random Rand value per month for delivered water and sanitation services, with the amount billed for not necessarily linked to the actual volume of water supplied or consumed on the property, neither the actual cost thereof.

The net effect is a scenario where customers do not need to take ownership of consumption, nor of private plumbing fixtures located on their properties, as reflected in the high levels of consumption and water wastage experienced at the time. Also of concern was the very high level of NRW, reaching almost 70%.

Because of the lack of metering, customers in reality do not receive the benefit of Free Basic Water (FBW), which represents just a fictitious 'book entry' on monthly municipal bills. Even customers who are poor or use water sparingly receive no real benefit from being frugal and are required to pay the same amount for water as customers using water excessively or irresponsibly.

After piloting the use of prepayment water meters, JW proposed implementing this technology on a large-scale throughout Soweto, as the most effective way of addressing deemed consumption, the lack of metering and the provision of FBW. Prepayment metering was also considered an appropriate solution to addressing behavioural deficiencies related to a lack of ownership of consumption and maintenance of on-property plumbing fixtures.

In addition to prepayment metering, JW also proposed the once-off repair and retrofitting of plumbing fixtures on private properties and the renewal of water networks in especially the older areas of Soweto.

The project was conceptualized for implementation over a 4 year period and was given the name Operation Gcin'amanzi which is a Zulu term best translated as Operation Save Water.

Objectives

The objective of Operation Gcin'amanzi was to create an efficient water supply system and achieve significant savings in total water supplied to the area by reducing excessive consumption and wastage. It was anticipated that the project would lead to savings of almost 20% in the water consumption for the city as a whole.

Figure 1: Working on the project in Soweto

Operation Gcin'amanzi was designed to add social and economic value to the community through:

- Improved water service delivery and customer interface,
- Rehabilitated municipal infrastructure,
- Rehabilitated private plumbing fixtures,
- Temporary and permanent employment for unskilled and semi-skilled labour in Soweto,
- Empowering of the customer to take ownership of water consumption,
- Net reduction in the cost of water to the end user,
- Dispensing of Free Basic Water to all residential properties, and
- Reduced municipal service arrears based on acceptance of the prepayment metering system.

Implementation

The project was launched in June 2003 after a lengthy consultative, awareness and approval process involving communities, councillors, ward committees, trade unions and other stakeholders.

A prototype phase was successfully completed in the suburb of Phiri towards the end of 2004. The objective of the prototype phase was to refine the implementation approach and methodology before rolling out the project across the greater Soweto region consisting of around 200 000 properties. Figure 1 below illustrates the labour-intensive construction practices used for the renewal of the water network. The total investment by the city and JW in Operation Gcin'amanzi once all phases have been completed is estimated at R1.2 billion.

Figure 2: Creating a water savings home

Results

Results achieved to date in completed areas are spectacular, with the average water supply volume per property dropping by more than 50 kℓ per residential property per month. This equates to a saving of R200 million per annum to JW in bulk water purchases alone, providing an effective payback period of less than 3 years on the investment made.

Although Operation Gcin'amanzi has received negative publicity – based mostly on misinformation and opposing political ideologies – the project is now supported at the customer level with nearly 98% of participating residents responding positively to project outcomes including the implementation of prepayment metering.

Ultimately, this project is ensuring that the true value of water is recognized and that customers are totally empowered to take ownership of consumption, thus ensuring that the service of water remains sustainable and affordable. Historically this is a first for the Soweto region.

Lessons Learned

Operation Gcin'amanzi shows the importance and value of creating water efficiencies at the municipal service delivery level through intervention and remedial action, especially when a host of complementary interventions are implemented simultaneously.

The issues around water supply in Soweto are not unique and occur in many urban areas in South Africa and abroad.

The results of this project demonstrate that Demand Side Management should at all times be considered as a cost-effective alternative to Supply Side Management, which often considers demand trends in isolation without due recognition to those factors contributing to that demand. The project also illustrates that significant public opposition can be replaced by the willingness of people to pay for reliable, clean water - once they experience the benefits and go through the ownership process.

Key Anticipated Results

- Estimated Energy Savings (when all phases completed) 175 000 mWh/year
- Cost Savings (estimated when all phases completed) R500 million per annum
- Water Savings (estimated when all phases completed) 97 200 000 kℓ/year
- Transfer of ownership of consumption to the consumer (a first in real terms for Soweto)
- Reduction in operating and maintenance costs due to water network upgrade
- Creation of over 1 500 temporary jobs in the communities where the project is being implemented
- Realization of the true value of potable water
- Improved sanitation

Project Highlights:

- ☑ Verified Savings
- ☑ Behavioural Change
- ☑ Political Endorsement
- ☑ Capacity Built
- ☑ High Level Management
- ☑ Cost Effectiveness
- ☑ Replicability
- ☑ Scalability
- ☑ Employment Opportunity

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T05

DRAKENSTEIN LOCAL MUNICIPALITY
DRAKENSTEIN GENERAL PRESSURE MANAGEMENT

Intervention Type	General pressure management
Reason	Drought and on-going stress on available water resources in the Western Cape
Cost	R9.5 million

The Drakenstein Local Municipality which includes the towns of Paarl, Wellington, Hermon, Gouda and Saron has faced shortages in the availability of water for especially municipal supply, along with other urban areas in the Western Cape including Cape Town, Stellenbosch and Somerset West. Shortages are linked to the availability of surface water in the Western Cape which has become water stressed. Water scarcity is especially pronounced during drought periods which have become more frequent, attributed by some to climate change.

Background

The Drakenstein Local Municipality is supplied with water mainly from Cape Town's Wemmershoek Scheme, supplemented by smaller dams and water treatment works on the Paarl Mountain.

During the 1990s, the municipality experienced growth in water demand averaging around 3.5% per annum. Coupled with this the level of Non-Revenue Water (NRW) continued to increase, reaching an unacceptably high figure of 37% in 1999.

"All the water that will ever be is, right now.."

- National Geographic October 1993

In response the municipality (then known as Paarl Town Council) approved a Water Demand Management (WDM) Programme in 1997, aimed at reducing overall demand for and wastage of potable water.

Proposed measures and interventions to address WDM included the introduction of a rising block tariff for residential water use, compilation of a computerised water network model and Master Plan, metering of unmetered connections (e.g. parks and industrial fire water), installation of district and zone water meters, a public awareness drive, installation of water saving devices and the implementation of a comprehensive pressure management programme. Pressure management was key to achieving water savings in terms of the WDM programme and involved the installation of Pressure Reducing Valves (PRVs) at strategic locations in the network characterised by high supply pressures.

Pressure Management

Generally, the management of pressure in water supply systems has proved effective throughout the world and in many parts of South Africa in reducing overall water demand.

This is especially true for areas that are characterized by high operating pressures and high levels of water loss attributable to leaking plumbing fixtures and aging municipal infrastructure.

Empirically, because of the power relationship between the volume of water passing through a hole or orifice in a pipe or fitting (the 'leak'), and the pressure of water in that same vessel behind the hole, even a small reduction in pressure leads to a dramatic reduction in the volume of water passing through the hole (the wasted water).

The Drakenstein pressure management project corroborates both local and international experience in the application of this technology, offering a best practice case study to other municipalities wishing to implement a similar type of intervention. As in Drakenstein, an incremental approach to implementation can be followed in which continual improvements and expansion of the pressure management system is made over time, resulting in further incremental reductions in supply volumes.

Description and Implementation

The project involved modelling, designing and establishing discrete water supply zones informed by bulk supply pipelines, general network characteristics, as well as natural boundaries such as the Berg River and undulating topography of the Paarl area.

Figure 1: Drakenstein Municipality area of jurisdiction

Once discrete zones had been physically established, supply to each zone was systematically managed through the installation of appropriately sized Pressure Reducing Valves (PRV's), some of which were later controlled using smart controllers. Smart controllers allow the pressure to be reduced further at off-peak periods, resulting in additional savings in the volume of water supplied.

Project Objectives

As stated, the main objective of this project was to reduce overall demand for potable water through the implementation of general pressure management in especially the Paarl urban area.

Achievements

The WDM programme of Drakenstein Local Municipality has been highly successful in achieving significant reductions in demand. Much of the achieved saving can be attributed to pressure management, which was the most significant technical component of the programme.

As can be seen from the graph below (Figure 3) representing the water demand of Paarl, the overall supply decreased significantly up to 2006, reflecting a level of supply last seen in 1989.

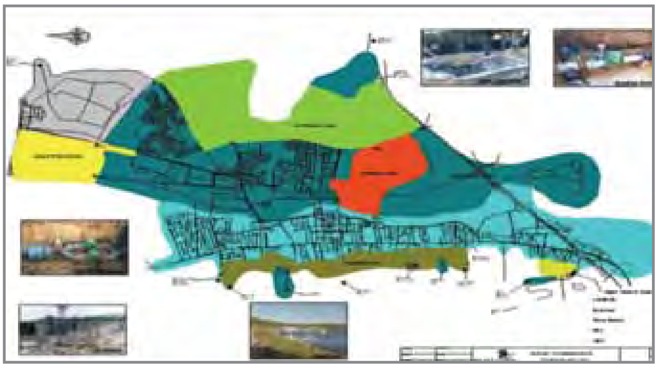

Figure 2: Established Pressure Management Zones for the Paarl urban area

When viewed against the long term projected linear growth in demand (based on the historical trend of 3.5% average growth per annum for the period 1988-1999), a saving of more than 50% has been achieved. This represents a saving of R29.5 million per annum to the municipality in bulk water purchase costs. Much of the saving can be directly accrued to the municipality given the losses in the network and the low payment levels in previously disadvantaged communities. As of 2008, the total cost of the WDM programme of Drakenstein was R9.5 million. Total savings of the project to date have been estimated at R129 million, illustrating the cost-effectiveness of the WDM programme and specifically Pressure Management component of the same programme.

In addition to the savings in demand, Non-Revenue Water (NRW) has decreased from 37% to 13% over the corresponding period.

Secondary benefits also include a reduction in pipe bursts, additional capacity in water and sewer networks and Wastewater Treatment Works (WWTWs), as well as quantifiable energy savings.

Lessons Learnt

Lessons learnt during the implementation of this programme are highlighted below.

- WDM programmes are most successful when a holistic approach to implementation is adopted that includes technical, social, behavioural and institutional interventions,
- Although pressure management is highly cost-effective, consideration needs to be given to certain supply characteristics such as measured Minimum Night Flow, nature of terrain, number of supply points, level of payment, condition of the network, etc,
- In order to sustain savings in water demand, implementation of pressure management should be proceeded by additional technical interventions aimed at fixing leaks and bursts in the network as well as on private properties,
- Subject to an overall implementation master plan, pressure management lends itself to a phased or incremental implementation approach whereby additional PRVs, controllers, etc. are installed as progress is made in reducing the level of leakage or minimum night flow, and
- Pressure Reducing Valves should be maintained and inspected regularly to ensure they are in proper working order. Failure of the valve or controlling equipment normally leads to loss of pressure control which defeats and/or negates the effect of pressure management and the resulting water savings.

Figure 3: Paarl Water Demand

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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T06

EMFULENI LOCAL MUNICIPALITY
ADVANCED PRESSURE MANAGEMENT

Intervention Type	Pressure management
Reason	High water losses because of leaks on properties and in the distribution network
Cost	R5 million

The Emfuleni Local Municipality (ELM) is situated south of Johannesburg in Gauteng and comprises two main city centres namely Vereeniging and Vanderbijlpark, and six large peri-urban townships namely Evaton, Sebokeng, Sharpeville, Boipatong, Bophelong and Tshepiso. The population of ELM is estimated at around 650 000 people living in approximately 194 600 households, of which 51.6% are deemed to be indigent. ELM supplies 6 million kℓ of water per month and it is estimated that 39% of the total volume of water supplied represents Non-Revenue Water and/or water losses.

Implementation of advanced pressure management to control the bulk supply of water to the Sebokeng/Evaton low-income residential area is a good example of the application of modern pressure control equipment and the resulting savings in volume of water supplied that can be attained.

"The crisis of our diminishing water resources is just as severe (if less obviously immediately) as any war-time crisis we have ever faced."

- J Wright, U.S. Representative

Because of the water-energy nexus, savings in bulk water supply can also be translated into energy savings and resulting reductions in Greenhouse Gas Emissions. Overall, a reduction in operating pressure also translates into savings in operating costs, as the number of pipe bursts is reduced.

Background

The area of Sebokeng/Evaton represents a large low-income residential area consisting of more than 70 000 formal properties provided with a high level of service consisting of pressured individual house connections and waterborne sanitation treated off-site at a large Wastewater Treatment Works (WWTW).

As is common in many former 'township' areas with a similar socio-economic profile to Sebokeng/Evaton, an excessive level of leakage was apparent, with high recorded Minimum Night Flows (MNF) of 2800 kℓ/hour and also high sewer night flows, measured at more than 90% of the MNF (or 2700 kℓ/hour). This pointed to a situation where broken toilets, cisterns and taps resulted in supplied water flowing straight through the distribution and plumbing system into the sewer conveyance system. In essence this problem can be attributed to a general lack of maintenance and repair of especially household plumbing fixtures on private properties. The high MNF could also partly be attributed to the premature failure of the water network due to higher-than-specified operating pressures.

It is important to understand that although pressure management alleviates the level of wastage taking place, it only addresses the effect and not the underlying cause of the problem which requires a behavioural change on the part of the consumer and assumption of ownership of both fixtures and water consumption.

Because water was being purchased by the municipality from a bulk supplier and payment levels by consumers for services provided were low, high leakage and wastage volumes represented a direct financial loss to the municipality.

Proposed Technical Solution

In response to the untenable water supply situation, the Water and Sanitation Business Unit of the municipality issued a Request-For-Proposals aimed at seeking potential solutions that could effectively address the high levels of leakage and wastage.

After adjudication of received proposals, an option involving the installation of a large pressure management station on the bulk supply pipelines to Sebokeng and Evaton was chosen as the preferred solution, because of its cost-effectiveness and potential to accrue water and financial savings to the municipality.

Potential to achieve savings through pressure management was based on detailed analysis of flow and pressure logging data using appropriate software such as Presmac®, Benchleak®, Econoleak® and Sanflow®. These are resources that have been developed by the Water Research Commission of South Africa and are freely available to users in South Africa.

The preferred option was also attractive to the municipality because the bidder offered a Turnkey type solution including financing of required capital, design, implementation, commissioning, training, as well as operation and maintenance over a 5-year period. In return, the bidder required compensation equivalent to 20% of savings accruing from implementation of the proposed solution over the 5-year period. The remaining savings of 80% would accrue to the municipality.

Included in the proposal was the use of advanced pressure management control to further enhance potential savings through additional pressure reduction at off-peak periods. Advanced pressure management also allows pressures to be maintained at a higher constant pressure during peak demand daytime periods.

Objective

The main purpose of this project was to reduce the high level of recorded leakage by installing Pressure Reducing Valves (PRV) with advanced controllers that reduce pressure according to a pre-set time-of-day schedule. It was calculated that the yearly payments by the municipality to the bulk water supplier could potentially be reduced by two-thirds through implementation of the proposed pressure management solution.

Implementation

In practical terms, implementation involved the installation of multiple PRVs on the two large water mains (1000 mm and 675 mm diameter respectively) supplying bulk water into the discrete (or ring-fenced) downstream supply areas of Sebokeng and Evaton, as illustrated in Figure 1.

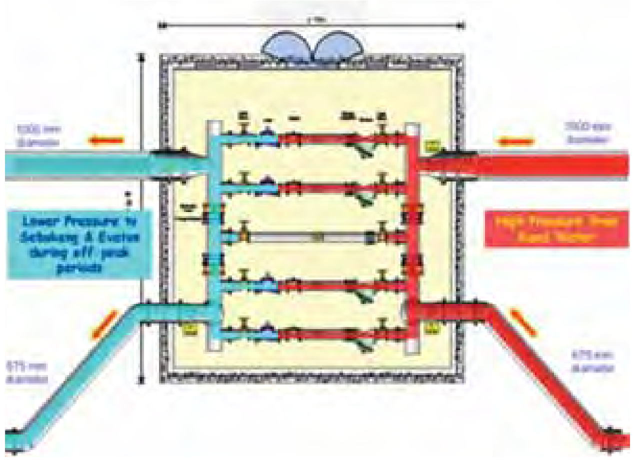

Figure 1: Proposed layout of pressure station

The nature and characteristics of the supply system lent themselves to pressure management because of:

- A limited number of supply points located upstream of the supply area,
- The potential to reduce operating pressures,
- The topography consisting of a gently sloping area downstream of the supply point,
- A high MNF both in terms of flow (compared to peak demand) and volume, and
- Low payment levels received by the municipality for services provided.

Innovation and Best Practice

The most innovative component of this project is considered to be the application of a Performance Based Contracting (PBC) mechanism to implementation, in terms of which the successful bidder was required to finance, design, build, own, operate, train and transfer the created asset to the municipality over an agreed contract period (in this case 5 years). In effect, this represented a small-scale BOOT or BOTT contracting arrangement which proved to be the most appropriate 'Special Purpose Vehicle' to transfer and manage technical and financial risk to the bidder or contractor.

As compensation for the assumed risk, the appointed contractor was remunerated 20% of the equivalent financial saving achieved based on the reduction in bulk water purchases from the bulk supplier resulting from implementation over the 5 year contract period. The remaining savings accrued directly to the municipality. Although the 20% savings level is low in terms of normal

PBC practice, given the high level of wastage and thus potential to achieve savings, it was considered adequate compensation for:

- Assumed risks and responsibilities,
- Cost of implementation, and
- Potential profit that could be gained by the bidder/ contractor.

Critical to the calculation of savings achieved in the volume of water supplied (post-intervention) was the establishment of a pre-intervention baseline determined by a statistical analysis of the 10-year supply history into the ring-fenced area of Sebokeng/Evaton.

As such, the project represents a successful small-scale best practice Private-Public Partnership (PPP), showcasing a the type of win-win situation possible through the transfer and management of risk to the private sector by means of an appropriate contracting arrangement aimed at improving operational efficiencies.

Benefits

Savings of around 583 000 kℓ per month of potable water supplied have consistently been achieved since 2005, representing a reduction of 25% of the recorded MNF prior to intervention.

These savings translate into energy savings of around 14 000 000 kWh/annum and also represent a reduction in Greenhouse Gas (GHG) emissions of more than 12 000 tons per year.

The graph in Figure 2 below bears testimony to the 'before' and 'after' situation regarding the recorded (or logged) supply (flow) of water into the project area. The effect of pressure management on both peak and minimum flows is amply evident. Also evident is the high pre-implementation night MNF.

Additional benefits that were accrued through this project are:

- Deferred capital expenditure for the upgrading of WWTW. Because inflows into the WWTW were reduced, upgrading of the capacity of the plant could be deferred for an estimated 10 year period,
- Improved network operating conditions. This unexpected benefit was the result of supply problems being identified once pressures had been reduced, highlighting basic network pipes, valves and connections that, although indicated as installed and operational on As-Built drawings, were in reality missing and/or could not be located. Various boundary valves were also found to be incorrectly operated. Corrective measures were taken to restore the network to its original operating configuration, and
- Highlighted bulk meter inaccuracies. After commissioning of the pressure management station which included the installation of bulk meters serving as check meters, the municipality was able to verify inaccurate bulk meter readings used for invoicing purposes by the bulk supplier.

Lessons Learnt

The application of advanced pressure management in Emfuleni is a good example of the type and magnitude of savings that can be achieved using state-of-the-art technology that reduces operating pressures according to a time related pre-programmed schedule.

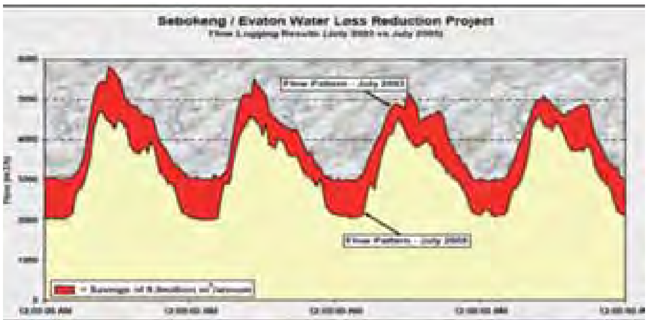

Figure 2: 'Before and After' Flow Patterns illustrating achieved water savings

Similar Case Studies

Other municipalities that have implemented advanced pressure management in South Africa include:

- City of Cape Town for the area of Khayelitsha and Mitchell's Plain,
- Drakenstein Local Municipality,
- Overstrand Local Municipality, and
- Mogale City Local Municipality.

Key Anticipated Results

- Innovative project financing solution
- Payback period less than 3 months
- Annual projected cost savings: R25 million
- Annual projected water savings: 7 000 000 kℓ (30% of pre-intervention supply)
- Annual projected energy savings of 14 000 000 kWh
- Annual GHG emissions avoided: 12 000 tons
- Innovative application of pressure management technology

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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T07

eTHEKWINI METROPOLITAN MUNICIPALITY

PRESSURE MANAGEMENT IN REAL TIME

Intervention Type	Pressure management
Reason	High water losses through leaking distribution system
Cost	R2.5 million

A water pressure management system was implemented in the Durban CBD as part of the Non-Revenue Water Reduction Master Plan to reduce water losses as introduced by the eThekwini Metropolitan Municipality's Water and Sanitation Directorate (EWS). Savings of 6 000 kℓ/day of potable water was achieved after the pressure management system was installed and commissioned.

Pressure Management

The loss of water from a water supply system through leakage decreases exponentially as the pressure of the water in a system is reduced. Therefore, pressure management is an effective way of reducing water losses attributable to leakage. A pressure management system has two functions. During low usage periods the pressure in the system increases and as the pressure increases the water losses through leaks increases exponentially. Therefore, the first function of a pressure management system is to reduce the pressure when it is not needed, reducing water losses and protecting the infrastructure lowering the number of pipe bursts.

> "All these strategic interventions will work together in the City's drive to meet the presidential directive of reducing water loss by half, by 2014."
>
> *- Specifile*

Secondly, a pressure management system maintains an acceptable optimum level of service during peak demand periods. If the pressure is too low then service levels are unacceptable, however, if the pressure levels are higher than needed then the water losses are higher. Pressure management ensures a reduction in water losses from leakages and maintains an optimal level of service.

Table 1: Phased Implementation Approach to Pressure Management

Phase	Description
Phase 1	The construction of a Pressure Reducing Valve (PRV) Station to control the CBD pressures and commissioning of the PRV station without any form of pressure control
Phase 2	Reduction of off-peak pressures by 10 m
Phase 3	Reduction of off-peak pressures by 20 m
Phase 4	Reduction of off-peak pressures by 25 m
Phase 5	Reduction of peak pressures by 10 m and off-peak pressures by 25 m

There are a number of different technical additions or variations in the implementation of different types of pressure management systems. However, all pressure management technologies use a hydraulic modulating valve known as a Pressure Reducing Valve (PRV).

The valve is designed to reduce incoming or supplied water pressure (which is normally variable) to a set and constant predetermined downstream pressure. Advanced Pressure Management is an evolution in pressure management that allows for multiple predetermined downstream pressure settings where the setting of the PRV, are a function of either time or flow. In other words the downstream pressure is changed on the PRV at a specific predetermined time or at a specific predetermined flow.

Real Time Control

Real Time Pressure Control represents a further advancement in pressure management where the downstream pressure is changed based on conditions being experienced in the network in real time. In other words the system based on the demand for water from the system adjusts the pressure optimal levels.

The Durban CBD now has Real Time Controlled Pressure Management Systems. Permanent pressure monitoring sensors installed at critical points in the network monitors and provides data on a real time basis of the pressure in the system. Intelligent algorithms, which take into account the characteristics of the network, continuously adjust the water pressure supplied to the CBD network and in so doing ensure that an optimum pressure is maintained at all times, meeting customer's needs, whilst minimizing water wastage.

Objective

eThekwini supplies 910 000 kℓ/day to 3.5 million residents through 440 000 service connections, but can only bill or account for 550 000 kℓ/day of that water. The main objective of this project was to reduce the known level of water losses taking place in the Durban CBD area through pressure management.

Even though the CBD had a high level of service (6 bar pressure) approximately 10 000 kℓ/day of the 38 000 kℓ/day supplied to the CBD was being lost, representing about R10 million/year in water purchases, or 3 600 000 kℓ/year of potable water, which is equivalent to 1.5% of Midmar Dam's capacity. There was thus incentive for the municipality to implement a state-of-the-art system to control water pressure to the Durban CBD.

Description

The Municipality, however, required that the system's design should include:

- Adjacent water supply zones and that these zones were to form part of the bigger plan,
- Maintaining the current peak water supply,
- Ensuring that the fire-fighting capacity was not compromised,
- Using PRVs in stock and avoid purchasing, and
- The installation of PRVs above ground, to municipal standards, and in as small as possible housing-facility as was practically possible.

Figure 1: PRVs

Special Considerations

As part of the implementation of the pressure management system an internal and external communication strategy was put in place. The Municipality was concerned that there could be changes on the water supply affecting the customers, leading to possible negative publicity. The objective of the strategy was to ensure that the level of service was not affected in the CBD. After each phase of the implementation, the water supply system and impact on customers was carefully monitored before implementing the next phase.

The communication plan comprised of three main actions:

- Informing the general public via the local newspaper, the municipality's website and legal notices,
- Addressing affected customers in the CBD through hand-delivered notices and registered mail notifications which included time-lines and the difference in responsibilities of the Customer and the Municipality (Customers were responsible for the installation of in-situ booster pumps to pump water into roof-top storage tanks), and
- An internal communication plan, which included workshops and one-on-one meetings, to improve the co-operation between the different Municipal departments.

Achievements

Non-Revenue Water (NRW) decreased by 5% for the City with a 32 000 kℓ/day, representing a cost savings of R38 million/year. Figure 3 represents the water consumption before pressure management was implemented with a dark blue line and the water saving achieved with a dark red line. The vertical dotted red line illustrates the Minimum Night Flow (MNF) which was significantly reduced. The MNF is the minimum flow (water supplied) during the night-time when there should be no water consumption and represents water loss/leakage in the water supply system. The reduction in the MNF with the implementation of the pressure management system is indicative of a reduction in NRW.

Figure 2: PRV and meter chamber

The communications strategy also proved to be extremely effective as not only did it facilitate a successful project, but a good relationship between the municipality and their customers was developed. This resulted in the compliance with the pressure management and regulatory standards by the customers in a prompt fashion allowing for the PRV station to be successfully commissioned and an appropriate level of service maintained.

Lessons Learnt

The significance of a focused and motivated eThekwini project team was recognised when the project was completed on time and within budget even though there were initial delays with the implementation because of a sudden increase of network failures just as construction work was to start. The team had realised the importance of the intervention because they had a quantifiable solution and as a result were motivated to achieve the goal of reducing water losses. The eThekwini team limited time delays by initiating a number of parallel actions to reduce the sudden unpredictably high volume of water losses due to old water pipes bursting.

Similar Case Studies

Other municipalities that have implemented different types of Advanced Pressure Management in South Africa include:

- City of Cape Town for the area of Khayelitsha,
- Drakenstein Local Municipality,
- Overstrand Local Municipality,
- Mogale City Local Municipality, and
- Emfuleni Local Municipality for the area of Sebokeng/ Evaton.

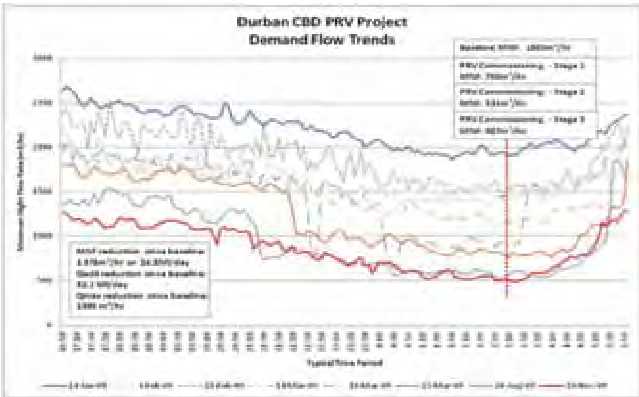

Figure 3: Changes in flow profile into Durban CBD at various stages of PRV commissioning

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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T08

CITY OF MOGALE LOCAL MUNICIPALITY

MUNSIEVILLE PRIVATE PROPERTY LEAK REPAIR

Intervention Type	Private property leak repair
Reason	Due to high levels of wastage, this project addressed leakage and municipal cost recovery for the provision of basic services
Cost	R1 062 000

Mogale City Local Municipality (Mogale) is located on the western side of the Gauteng Province and comprises a mixture of urban, peri-urban and rural areas. Urban areas include Kagiso, Rietvallei, Azaadville, Krugersdorp, Munsieville, Muldersdrift, Tarlton, Magaliesburg and Hekpoort. The total population of the municipality is in the region of 350 000, of which 28% do not earn an income.

Bulk water purchases from Rand Water and Johannesburg Water amount to 2 million kℓ/month, of which 30% is attributed to Non-Revenue Water (NRW) or water losses (both real and commercial losses). Mogale City has received Blue Drop Certification from the national Department of Water Affairs.

Figure 1: Cistern leaking 1ℓ every 23 seconds

In a drive to reduce water losses, Mogale City initiated a private property leak repair project in Munsieville, a previously disadvantaged low-income area consisting of around 2 500 formal dwellings. As the municipal water supply to this area was ring-fenced, it was established that the bulk of the leakage was occurring beyond the meter, or on the privately owned properties.

The need for Leak Repairs

A technical audit done in Munsieville found that many toilet cisterns were flowing continuously because of mechanical failure of the inlet float valve, flushing mechanism or the sealing washer at the outlet pipe.

Figure 2: No Operating Float valve to stop the cistern from over-filling

The cistern shown in Figure 1 above was measured as having a leakage rate equivalent to 112.7 kℓ/month, which is almost 19 times more than the 6 kℓ Free Basic Water

(FBW) per month volume. This is typical of water wastage resulting from a failed toilet mechanism, common in many low-income areas throughout South Africa.

The toilet cistern in Figure 2 was missing a float valve, which closes off the water supply to the cistern and prevents over-filling. The owner had, as can be seen, resorted to tying the float valve to a nail in the wall in a raised position to contend with the failure. Water wastage arising from this type of failure adds no beneficial value to either the owner of the property or the municipality. Residents in poor areas are often ignorant of these leaks or the impact thereof, due to a lack of awareness and education.

Given the fact that South Africa is a water-scarce country, it is imperative that this type of easily identified and rectifiable water wastage be addressed as a matter of urgency. The cumulative effect of leaks of this nature artificially contributes to the water demand of urban areas and abstraction of water from surface water resources, thus compounding existing stresses on the system

The implementation of household leak repair projects can go a long way to redressing this wastage problem and conserving water resources.

Objectives

The main aim of this project was to reduce water wastage and develop a methodology for undertaking larger-scale projects of this nature that include repairing, retrofitting, and/or replacing household plumbing fixtures.

By eliminating wastage the project also aimed to address municipal cost recovery for the provision of basic services. Other objectives also included:

- Job creation,
- Skills training,
- Empowerment of local community members for a sustainable future,
- Community awareness,
- Community upliftment,
- Energy savings, and
- Protection of the environment.

Implementation

Initially an assessment was conducted in order to determine the extent of leaking fixtures in each household, after which a job card was developed that provided detail relating to the material and repairs required for each house. Generated job cards could then be used to manage the issuing of materials and work done by contractors to effect repairs.

Although standpipes, meters and pipes were found to be the source of some of the leaks, the main cause of water wastage could be attributed to broken toilet cisterns. Plumbing repairs were effected on 1 075 of the more than 1 200 properties audited and included the replacement of cisterns, as well as repair/replacement of taps and water pipes.

The project also piloted the use of the so-called "leak free" cistern, which has been designed to fail in a closed water supply position, thereby potentially minimizing water wastage.

The photograph shown in Figure 3 represents a 'before and after' scenario of a toilet repaired as part of the project. This toilet served approximately 25 families who lived in informal dwellings and had to share the available ablution facilities. After completion of repairs, the households concerned assigned a person to clean the toilets and lock them after usage, to ensure they stayed in a clean, working and sustainable condition.

Due to additional budget becoming available, the project was also able to address leakages at local schools and provide access to toilets for handicapped and disabled persons at community facilities.

Results

Before commencement of the project, average consumption per household in the project area was about 31.7 kℓ/month. After completion of the project, consumption had reduced to 23.3 kℓ/ month. This represented a savings of approximately 12 000 kℓ/month for the beneficiary area, or almost 30% reduction by R352 000 per annum. Figure 4 illustrates the impact of the project on the supply trend, from initiation to completion.

Figure 3: Toilet that was repaired as part of the project

Lessons Learnt

The most important lessons learnt through implementation of this project were:

- During implementation community meetings were held with the Ward Councillor of the area, community leaders, prospective plumbers, plumbing suppliers and the Department of Labour. Through this process, it was established that the disabled and especially those using wheelchairs did not have easy access to the toilets, thus providing an opportunity for the project to assist in improving access. Through the building of access ramps, breaking out walls and installing hand-rails, access to toilets was provided to the disabled. The lesson learnt is that by engaging and interacting with beneficiary communities, the needs of the community can be better understood and vital information gleaned through a process of consultation.
- The services of a plumbing auditor were utilized to ensure that repairs were effected in private houses were acceptable. This process also included the signing off of repairs by the home owners.
- Based on the minimum night flow measurement taken after completion of the project, it was evident that there had been a 38% reduction in the leakage rate, resulting in the municipality's bulk purchases being reduced.
- Attention was paid to rolling out an awareness campaign to ensure that the community understood the importance and objectives of the project, the need to conserve water as well as convey best practice related to water use efficiency. Each household in the project area was visited by a Community Liaison Officer to discuss the leak repair project and hand out a brochure containing information relating to the project, water savings tips, and information on how to fix leaks, general awareness of water and the environment as well as contact details of the municipality. As part of the project launch activities, a soccer festival was also held in Munsieville.
- An investment was made in skills development and job creation aimed at enhancing the sustainability of project impacts after implementation. The project was able to employ 34 previously unemployed people during implementation, of which 11 where female. This contributed to overall skills transfer and local economic development.

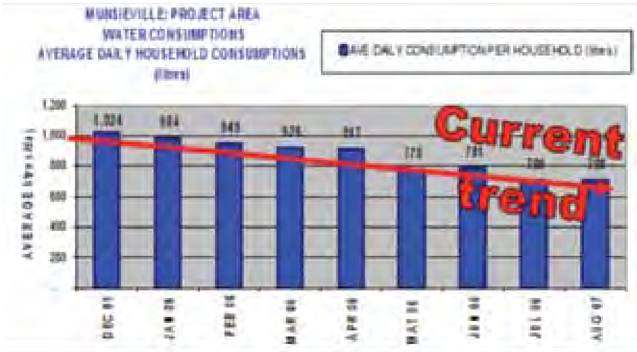

Figure 4: Munsieville Water Consumption

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T09

DRAKENSTEIN LOCAL MUNICIPALITY

SARON LEAK REPAIRS ON INDIGENT PRIVATE PROPERTIES

Intervention Type	Indigent leak repair
Reason	High water losses due to high leakage levels on indigent properties
Cost	R1.5 million

The Drakenstein Local Municipality (DLM) has a population of more than 200 000 people residing in areas which include the Paarl, Wellington and the small towns of Hermon, Gouda and Saron. Saron is situated 80 km to the north of Paarl with a population of 6 000 and a 64 777 kℓ/month demand for water. Non-Revenue Water (NRW) was in the order of 34%.

The DLM, through a process of logging water supply networks in their area, found that minimum night flows (MNF) in Saron averaged 27 267 kℓ/month. High MNF is an indication of high water losses that can be attributed to leaks in the network or open taps or leaks in houses. MNF is the flow in the water supply network (or demand for water) during the early hours of the morning. This is when the normal water consumption by sleeping residents is at its lowest and should theoretically be zero. A leak repair project was thus undertaken by DLM to address the high water demand due to leakages on indigent domestic properties.

> "Approximately 1 in every 318 homes or buildings has a leak."
>
> *- Smart Leak Detection and Smart Plumbing*

Indigent Leak Repair

Indigent leak repair is the identification and repair of leaking plumbing fixtures on the private properties of low income households. It has been found that the indigent are more likely to have leaks on their properties because they are not readily able to repair these leaks and they often have poor or illegal connections which are known sources of leaks. Due to these leaks generating high consumption bills, indigent households are also most often not able to address their non-payment for water once they are in arrears with their payments. Research shows they are more likely, once they have stopped paying for water, to be more wasteful. Furthermore the lack of repairs in indigent areas leads to high levels of water wastages and water losses over time.

Figure 1: Leaking plumbing fixture

The low economic status of indigent households and the entrenchment of the behaviour of non-payment for services have resulted in lost revenues for municipalities. A research done on RDP houses by Van Zyl, Lobanga, Lugoma & Ilemobade (2008) found that in more than 50% of the houses, plumbing fixtures were either broken or leaking. Indigent leak repair is thus seen as an important undertaking to reduce water wastage and conserve natural water resources.

Objectives

The objective of the project was to identify and repair plumbing fixtures in indigent households where there were water leaks on their properties in an effort to reduce the high levels of water wastage.

This included raising the awareness of the residents that their water consumption was high, the need to conserve water and the reasons why it was important to pay for services.

Implementation

A resolution at a council meeting saw the Department of Water Affairs making R2 million available for the implementation of the project with a further R500 000 contribution from the DLM itself.

The initial step was the appointment of a service provider to:

- Interact directly with the owner/tenants of the properties, informing them of the intended purposes of the project and also pass on information on water savings practices using brochures,
- Identify leaks on properties through an audit of each of the properties,
- Repair the leaks by going onto the properties and fixing the plumbing fixtures, and
- Educating the property owners/tenants to identify water leaks and do basic plumbing repairs.

Work commenced in February 2009 in which 1 413 properties were visited and 1 178 properties had plumbing repairs completed.

Results

The project achieved a saving of 12 363.84 kℓ/month as measured against the MNF. Figure 2 depicts the MNF of 2009 compared with 2008. MNF in 2008, represented by the purple line decreased from about 10 ℓ/s to about 6 ℓ/s in 2009, represented by the red line.

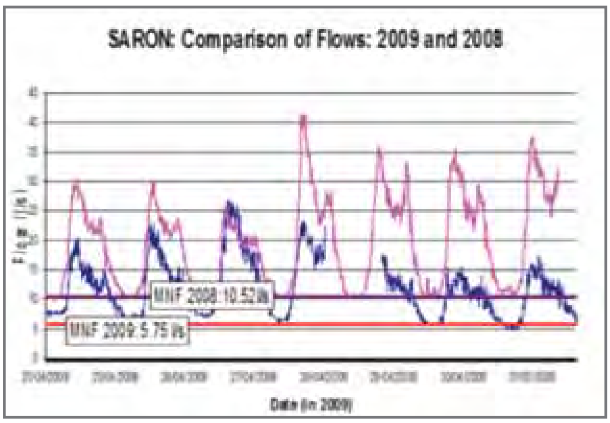

Figure 2: Minimum Night Flows

The overall demand for water in the area also decreased as a result of the repairs. Table 1 shows the statistics of the repairs completed during project. An added benefit was that there was no longer a need for an additional reservoir and there was now capacity to meet the growth in the area. The construction of the new reservoir was put on hold saving the DLM the construction costs.

Lesson Learnt

- Repairing plumbing in indigent homes is an important intervention in the effort to conserve water,
- Non-paying residents generally do not repair their plumbing fixtures and wastewater,
- It is in the interest of the municipality to implement a leak repair project because there is a reduction in water losses. There is also a cost recovery over time that will also cover the costs of the leak repairs,
- As water savings are achieved the cost of water supplied is lowered and the percentage of revenue collected improves. In other words the cost recovery of water improves leaving the municipality with less of a financial burden,

Table 1: Statics of the Project

Statistic	Value
Number of properties visited	1,413
Number of properties repaired	1,178
Percentage properties with leaks	83.40%
Percentage properties repaired with cistern leaks	30.90%
Percentage properties repaired with leaks on pipes	64.20%
Total cistern leaks	364
Multi-flush cisterns installed	292
Total other leaks on cisterns	72
Total Tap Leaks	1,475
Taps replaced	1,352
Other tap leaks	123
Stopcocks replaced	254
Properties with pipe leaks	756
Metres of pipe replaced	8,335
Average pipe length replaced per property	11

- The education of the community on the benefits of the project, the potential risks of water wastage and basic leak detection and repair goes a long way in ensuring a longer sustained success of the project, and

- Perceptions and attitudes surrounding the water conservation and water demand management need to be influenced in order to bring about a change in behaviour which will lead to the more efficient use of water.

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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EMFULENI LOCAL MUNICIPALITY

SHARPEVILLE PRIVATE PROPERTY LEAK REPAIR

T10

Intervention Type	Indigent leak repair
Reason	High water losses due to high leakage levels on indigent properties
Cost	R1.5 million

Situated in the south of Gauteng and comprised of two main city centres, namely Vereeniging and Vanderbijlpark, is the Emfuleni Local Municipality (ELM). Also included in the area of jurisdiction of the municipality are the low-income areas of Evaton, Sebokeng, Sharpeville, Boipatong, Bophelong and Tshepiso. The population of ELM is approximately 650 000 people living in 194 600 households, of which around half are deemed to be indigent. The high number of indigents seriously affects the sustainability of water services, especially given that the municipality supplies 6 million kℓ of water per month, of which 39% is considered as Non-Revenue Water (NRW).

> "A leak the size of a pinhead can waste 31362748.24 litres per year, enough to fill 12,000 bathtubs to the overflow mark."
>
> *- Smart Leak Detection*

Water and sanitation services are provided by Metsi-a-Lekoa (Metsi), a ring-fenced business unit mandated by ELM to provide water and sanitation services to residents of the municipality. Metsi is also responsible for the operation and maintenance of installed water and sanitation infrastructure.

Increasing Demand Decreasing Affordability

The water demand in the Gauteng Province has continued to increase at a long term average of 2.5% per annum. Much of this increase can be attributed to on-going migration and natural growth of the urban population, as also experienced by ELM. Unfortunately the growth in demand has not necessarily been matched by the consumer's ability to pay for water services, creating a sustainability problem for the continued delivery of services by said municipality.

This scenario set the scene for Metsi to initiate and implement a Water Conservation and Water Demand Management programme, which included a private property leak repair project in the Sharpeville area.

Funding for the project was provided by the Coca Cola Foundation, United States Agency for International Development (USAID), Department of Water Affairs (DWA), as well as the local municipality.

The Case for Leak Repairs on Private Properties

In South Africa, leaks on private properties especially in low-income areas, have been identified as one of the major causes of water wastage, which can be as high as 80% of total water supplied by the municipality. These leaks can be attributed to the use of poor quality plumbing fixtures, excessive pressure in the water supply system and also a general disregard for the efficient use of water by the serviced customer. The value of potable water supplied into homes is also not always fully appreciated.

Most times these leaks are accompanied by a high rate of non-payment for services, further compounding affordability issues for the municipality.

The sources of leakage on private properties can be traced back to toilet cisterns in particular, but also taps, geyser control valves, and dilapidated piping.

Hence a strong business case can be made for repairing leaks on private properties in those areas where non-payment for services is high and water wastage is prevalent. This type of intervention offers a favourable return on investment to the municipality, especially in cases where the municipality purchases bulk treated potable water from a bulk supplier (as with Emfuleni).

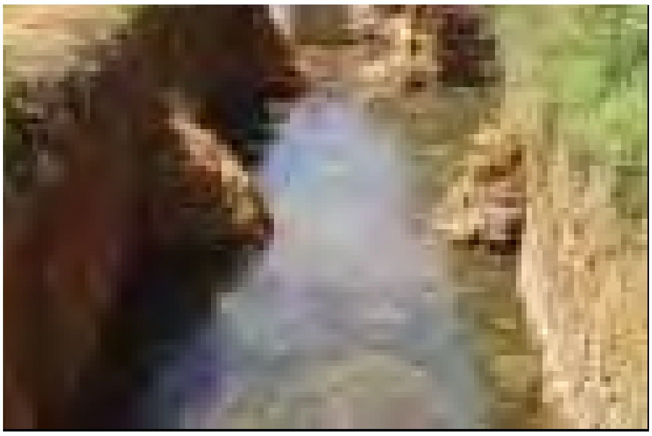

Figure 1: Broken water pipe near George Thabo Stadium which diminished water savings achieved

The cost of repairing leaks is recovered through achieved water savings, often in less than a year.

Objectives

The aim of this project was to repair/replace/retrofit plumbing fixtures (cisterns, taps, pipes, etc.) on private properties in a previously disadvantaged community in order to reduce high levels of wastage, whilst simultaneously addressing municipal cost recovery for the provision of the basic services. Additionally the project aimed to create local employment opportunities for Community Liaison Officers (CLOs) and Learner Plumbers from Sharpeville.

Figure 2: Leaking network valve

Scope

The scope of the project encompassed the entire Sharpeville area consisting of 4 500 stands or houses. A total of 24 learner plumbers from Sharpeville were appointed to the project and received formal training in plumbing skills at an accredited training facility. Two Community Liaison Officers received on-the-job training and were employed for the duration of the project.

Achievements

Overall water demand in Sharpeville did not reduce significantly after implementation, due to various challenges which have been highlighted below. This also meant that the cost of interventions could not be offset against achieved water savings, seriously questioning the success of the initiative.

As can be seen in Figure 4 below, savings in water supply achieved directly after implementation were estimated to be in the region of 15 600 kℓ/month or equivalent to R83 000/month. These savings were however not sustained in the longer term and soon after intervention overall volumes of water supply returned to pre-intervention levels.
The project did however have other benefits such as the improvement to plumbing fixtures on more than 80% of all properties in the beneficiary area.

Challenges

It is thought that water wastage resulting from broken water pipes due to road construction activities in Sharpeville at the time of implementation of the project greatly diminished the volume of water saved through repaired leaks on private properties. Of note is a large leak that occurred near the George Thabo Stadium, as illustrated in Figure 1. Even though every effort was made to trace this leak, the actual leaking pipe was never located.

In addition a number of leaking mains and valves identified by the project team during the assessment phase of the project were reported to the municipality, but were never attended to or repaired. The leaking valve shown in Figure 2 was reported to the municipality but was not repaired for a number of months.

In some houses replaced plumbing fittings were found to have been stolen and/or vandalised shortly after the project was completed, leading to recurrent water wastage after intervention implementation. Figure 3 is an illustration of continued vandalism shortly after completion of the project, resulting in continued water wastage.

Figure 3: Vandalised toilet soon after installation

Lessons Learnt

Lessons learnt during implementation are highlighted below.

- Communication with the community is critical to success of a project of this nature and a dedicated CLO should be appointed to liaise with the community on all project matters,
- Every effort should be made to use only plumbing fixtures that have no scrap value, so as to avoid theft and resulting water wastage,
- The municipality and/or beneficiary community must buy into and adopt the project as their own, to ensure sustainability and success. It is recommended that learner plumbers be permanently employed by the municipality after completion of the project so as to incentivise them to continue with repairs and in so doing minimize wastage, and
- Network related leaks and bursts should also be attended to by the municipality within an acceptable period of time. If not attended to, any savings achieved through the repair of small on-property leaks will quickly be negated by the bigger network leaks and bursts and the benefits of the project will very quickly be lost.

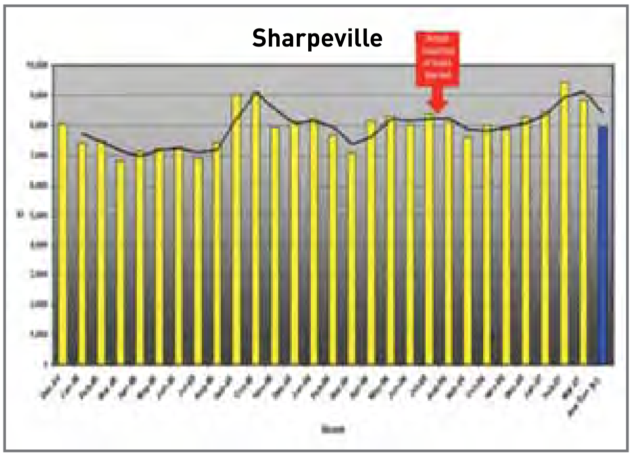

Figure 4: Water supply into Sharpeville during and after the project

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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eTHEKWINI METROPOLITAN MUNICIPALITY

WATER RECYCLING

T11

Intervention Type	Water recycling
Reason	Capacity of WWTW and sea outfall pipe line limited
Cost	R18 million

In the early 1990s the eThekwini Metropolitan Municipality's (eThekwini) Southern Wastewater Treatment Works (WWTW), including the sea outfall pipeline, capacity had been exceeded and needed to be extended. However, the eThekwini Metropolitan Municipality was confronted with the high capital, operating and environmental related costs. After some research, eThekwini's Water and Sanitation Directorate (EWS) identified the potential of reusing the effluent which would in turn address many of the costs and environmental issues as well as reduce eThekwini's demand for water.

"In an age when man has forgotten his origins and is blind even to his most essential needs for survival, water – along with other resources – has become the victim of his indifference."

- Rachel Carson

Effluent Re-Use

As the water demand from the community grows, the infrastructure to supply water needs to be extended which, in turn, has an impact on the cost/kℓ of water supplied. By reusing a WWTW's effluent less water is disposed of and less water is abstracted from existing water resources. Infrastructure upgrades and augmentation schemes can then be postponed whilst also freeing up capacity to support growth and development in the community.

Reasons

eThekwini needed to extend their Southern WWTW urgently as well as the effluent disposal facilities as the growth in the southern Durban area exceeded the capacity of the WWTW.

eThekwini was also, when considering the expansion of the WWTW and sea outfall pipeline, under pressure to address the environmental impacts and legal implications associated with discharging wastewater.

Objectives

The overall project objectives (See Table 1) had to address the need to treat the increased volumes of wastewater from the southern Durban area and simultaneously reduce the capital costs of new infrastructure. A practical sustainable alternative of disposal of the WWTWs effluent, as well as environmentally acceptable options, had to be found.

Description

During the same period that eThekwini was trying to find alternatives to effluent disposal Mondi Paper (Industry) was planning to upgrade their existing water reuse/recycling facilities in order to increase their water supply to increase paper production. Pilot trials showed that with the tertiary treatment of a domestic effluent from the WWTW's activated sludge plant a sustainably source of water of an acceptable quality fit for industrial use could be produced.

In 1996, under pressure to address the increasing volumes of wastewater, EWS went ahead and constructed a second 50 Mℓ/d primary and secondary treatment facility at the Southern WWTW, which was able to treat wastewater to a quality that would be acceptable to discharge on-shore (better quality than sea-outfall and more environmentally acceptable).

In 1997 an economic assessment confirmed that the sale of effluent from the second Southern WWTW's effluent would be economically feasible if reclaimed as high quality water.

Figure 1: Durban Water Recycling Plant

It was also recognised that the requirement for capitalisation for treating water to a higher quality, the technical proficiency due to the complexity of the water treatment operations and the operational management of a tertiary treatment facility was not part of the EWS's mandate. A Public Private Partnership (PPP) was then established through a bidding process and the Durban Water Recycling (Pty) Ltd Company was subsequently set up in 1999. In 2001 the Durban Recycling Plant was commissioned with a design capacity to treat 42 Mℓ/d of "treated" domestic wastewater effluent from the Southern WWTW to a quality fit for industrial use.

General Features of the Intervention

The first phase of the project was the expansion of the second water treatment plant, which was later purchased by Durban Recycling (Pty) Ltd. This is a conventional activated sludge plant and its capacity, both the biological treatment and hydraulic capacity of the plant, were increased with an additional clarifier to improve the quality of effluent for further use.

Table 1: Project Objectives

Objective	Status	Description
Expansion of secondary wastewater treatment plant	Completed in 1997	Enables effluent to be discharged to sea at the Umlaas Canal, and supplies tertiary water treatment plant with effluent
Construction of tertiary water recycling plant	Completed in 2000	Treats effluent and sells treated water to industrial consumers

The second phase of the project included the construction of the Water Recycling works. This plant was constructed with a treatment capacity of 42 Mℓ/day, and currently treats about 37 Mℓ/day (optimum operating capacity) of domestic effluent from the WWTW to a water quality standard suitable for sale to industrial consumers.

The final treatment of the WWTW's effluent includes lime dosing, Lamellar plate settling, polymer dosing, pH adjustment (using carbon dioxide), dual media filtration (using anthracite and sand), inter-ozonation (using liquid oxygen as feed) and final polishing using granular activated carbon.

Achievements

Despite the complexity of the project and the space constraints on site the project was completed in 10 months. Since commissioning the plant in 2001 37 Mℓ/day of potable water is now being saved by eThekwini.

Further, 37 Mℓ/day of sewage effluent is no longer being discharged into the sea. This has led to important cost savings as there is no longer a need to increase the capacity of the WWTW's sea outfall discharge infrastructure. There is also a significant reduction of the impact from the WWTW on the environment.

Further a win-win-win workable Public Private Partnership (PPP) deal was tabled that would benefit eThekwini (cutting costs, addressing the need to treat additional wastewater volumes and limiting the environmental impact). Local industries (albeit only a limited number of industries) benefitted by having access to an additional volume of water at almost half the cost. There was the establishment of a private operating consortium which would increase technical capacity and job opportunities in the eThekwini community.

Lessons Learnt

The initiation of the Public Private Partnership and then the collaboration between the newly established Durban Water Recycling (Pty) Ltd and EWS was instrumental to the success of the project. The success of the project was also because of the innovative approach of the contract which allowed scope for a financial model to be implemented that would provide capital for construction.

During the project there was also the realisation that the use of effluent from a WWTW is not always as straightforward as expected. There are different types of effluents which have different waste loads depending on the volumes of wastewater discharged by industries or by residents. The waste load from industrial areas will vary significantly from area to area and even from hour to hour during the working day. However, the waste load from a residential area is fairly constant in quality and basically only varies in volume depending on the time of day.

Table 2: Project Achievements

Achievements
Reduces City Water Consumption
Reduces treated wastewater outflows by 10%
37 Mℓ/day sewage is treated at a substantial discount
Reduced the volume of waste from the secondary plant by 70%
Due to the close interaction of the South African Engineers with their French counterparts, a vast amount of technical and commercial capacity was developed

It is also simpler to treat the effluent waste load from a residential area because it is mostly organic in nature and because a large percentage of the influent (water received) at a WWTW is "grey" water and wasted clean potable water (from open taps, malfunctioning toilets, etc.) diluting the concentration of the waste load in the influent.

There are, however, a number of other obstacles to using a WWTW's effluent, many of which eThekwini were not faced with. These included:

- WWTWs are sited at the lowest point of the regional topography so that the wastewater can be feed to the WWTW by gravity. As a result the WWTWs are located far from potential users and the cost of pumping this water back to potential users exceeds the cost of existing supplied potable water,
- Dual water supply systems are costly and impractical, and
- National water authorities include the volume of effluent discharged into a surface water resource, as a return flow, and therefore, as part of the available water resources for downstream users and do not allow the effluent to be reused.

Similar Case Studies

Sol Plaatje Wastewater Re-Use.

> "A special feature of the PPP deal was that it was a "Win-Win-Win" situation: The industries win because they currently get their water at approximately half the price of potable water, eThekwini Municipality wins because it gets approx. 37 Mℓ/d of sewage treated at a reduced cost plus potable water is made available for another use, and the private partner is making a profit."
>
> *- Harrison J, 2011*

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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WATER RESEARCH COMMISSION

T12

SOL PLAATJE LOCAL MUNICIPALITY

GREYWATER MANAGEMENT

Intervention Type	Water reuse
Reason	Implemented a greywater system for the reuse of greywater due to scarce water resources
Cost	R1 713 520.00

We Serve

The Sol Plaatje Local Municipality (Sol Plaatje) is located in the Northern Cape and has a population of 245 000 with an indigent population of 74 000. The municipal area includes the towns of Kimberley and Ritchie.

Sol Plaatje receives an average of 200 mm/year rainfall which is less than half of the national average. The municipality has recognised the importance of implementing Water Demand Management/Water Conservation (WDM/WC) interventions.

Galeshwe, Kimberley, is a previously disadvantaged area located 3 kilometres from the city centre, which was given a housing project to provide for low income housing. The project focused on creating a socially, economically and racially integrated community in a life-style which would ensure a sustainable environment. This presented an opportunity to test alternative environmental technologies or practices such as the use of greywater which, with the limited water resources, is seen as a viable alternative to the abstraction and use of the existing local water resources.

> "The beauty of greywater is that it's constantly generated, unlike rainwater or stormwater which has to fall from the sky before it can be harvested."
>
> *- Dr Wendy van Dok*

Greywater Use

Greywater is household wastewater which originates from bathing, washing of dishes and the washing of laundry. This water differs from blackwater which includes contaminants from faeces and toxic chemicals normally associated with water flushed in the toilet.

Greywater makes up 50-80% of all residential wastewater and the use of this water can become an important source for the irrigation of gardens and agricultural plots in an area that has scarce water resources.

The use of greywater has the positive impact of reducing the volume of water abstracted from local water resources. Other benefits include:

- Reducing the amount of sewage that must be treated extending the life of the wastewater treatment works, and
- Extending the life of the sewage works reduces the financial burden on the municipality to extend and or operate the works.

Objectives

The objective of the project was to test different affordable environmentally sustainable low income housing concepts, with the intention of replicating the applicable best practices on a larger scale in Moshoeshoe, and then at a later stage role the project out to the whole municipal area. Amongst other initiatives around ensuring that the project was sustainable, affordable and practically implementable was the key objective to provide greywater as a source of water to meet the community's needs for the irrigation of gardens.

Description

In partnership with the Swedish International Development Co-operation Agency a pilot project, the Moshoeshoe Ecovillage in Galeshewe, was set up to determine which environmental technology and building best practices could be implemented in future that would be suitable and feasible for the larger housing development to be undertaken in Sol Plaatje. Greywater systems were installed in all the houses diverting greywater to gardens and agricultural plots. Greywater was collected from the kitchen and bathroom and piped via a network connection to a centralised system in the area.

The greywater is first allowed to pass through a sand filter and is then discharged into a common pond. The water from this pond is then used to irrigate gardens and other agricultural initiatives.

One of the main outcomes of pilot tests showed that it was possible to provide a low maintenance onsite treatment of greywater that was sufficient so that the water could be used for irrigational purposes.

Residents went through a training programme which highlighted to them the importance of maintaining the greywater system, which included what type of household chemicals should be used, and understanding the financial savings that would be accrued as a result of using a greywater system.

Results

The Eco-village Pilot Project saw 11 houses being built, each connected to the centralised greywater system. According to a research study undertaken by Hoogendoorn, Lenka, & Marais (ca2006), 8% of the interviewed residents were happy with the system, and a further 30% stated that they were satisfied.

As a direct result of using greywater, residents pay less for municipal water services. Less water is being abstracted and less water is being discharged to the sewage treatment plant.

However, the agricultural plots were not a success. The residents were not willing to maintain the agricultural plots after a full day's work.

Lessons Learnt

- By combining the greywater in a centralised system reduces capacity related issues when compared to having a separate greywater system for each unit,
- The education of residents is needed to ensure that they understand the benefits of and buy-into the concept of using greywater,
- The perceived prejudice of alternative housing needs to be dispelled through workshops and demonstrating the success of the project,
- Residents should participate in the project from its inception and planning stages with the involvement of the community, politicians, the municipality, province and financiers.
- The project should be as flexible as possible to allow for changes and improvements to be made once feedback has been received and as new lessons and challenges which constantly present themselves can be addressed together with the community.
- Urban agriculture was not particularly popular amongst the beneficiaries. If urban agriculture is to be part of the approach it needs to be driven by a dedicated person or organisation providing training, support and the financial motivation to make a gardening venture successful.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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WATER RESEARCH COMMISSION

T13

SOL PLAATJE LOCAL MUNICIPALITY

WASTEWATER REUSE

Intervention Type	Water Reuse
Reason	Excess effluent discharge into the Kamfers Dam pan due to a lack of capacity at the wastewater treatment works.
Cost	Unknown

We Serve

The Sol Plaatje Local Municipality, which includes the towns of Kimberley and Ritchie, is located in the Northern Cape and has a population of 245 000 of which 74 000 are indigent. Water supply infrastructure is aging and there is a backlog of the construction of new networks to accommodate the ever increasing growth in population all of which is contributing to the high water losses and wastage.

Sol Plaatje operates and manages the Homevale Wastewater Treatment Works (HWWTW). The works has been designed with a capacity to treat 30 000 kℓ/day of domestic wastewater and the final effluent from the works is discharged into the Kamfers Dam.

The Kamfers Dam is a large wetland, which is one of only four places in the whole of Africa where the spectacular Lesser Flamingo breeds.

"In addition to conserving highly treated, expensive drinking water, wastewater reuse reduces the release of nutrient-rich wastewater into environmentally stressed streams and rivers."

– Caigan McKenzie

Due to deteriorating infrastructure and the growth of the population the HWWTW was no longer able to adequately treat Kimberley's increased volumes of domestic wastewater. The volumes of treated effluent being discharged by the HWWTW have increased significantly and the quality of the effluent has deteriorated as a result.

This is causing the Kamfers Dam's water levels to rise and water quality of the dam to deteriorate which is now posing a threat to the island, to the breeding habitat of the flamingos and the railway line.

According to research conducted on the impacts of the discharge from the HWWTW on Kamfers Dam, the total volume of effluent to be discharged into the pan should not exceed 25 000 kℓ/day (including rainfall). Where current volumes discharged are in excess of 30 000 kℓ/day (excluding rainfall).

In early 2008, Sol Plaatje was issued with a pre-directive of non-compliance by the Department of Water Affairs prohibiting the municipality from authorising or allowing further development that would impact on the volumes of treated effluent to be discharged by the HWWTW. The municipality followed instructions by suspending all development until such time as the capacity of the WWTW was increased and quality of the effluent had improved.

Figure 1: Semi-submerged Flamingo Breeding Island

Wastewater Reuse

Effluent from a treatment works such as the HWWTW can either be discharged back into the environment or be reused. Depending on the intended use of the effluent, the effluent can be treated further and used for a number of different agricultural or industrial purposes including reused as water for domestic purposes.

Droughts, population growth and the continued misconception that water is an unlimited resource are the main causes of water shortages in arid areas around the globe. Thus, the reuse of wastewater is becoming an important water conservation tool in reducing pressure on South Africa's limited water resources. From the perspective of water demand management, by reusing wastewater, an alternative source of water is "created" and the conventional water resources are conserved.

Objective

The project sought to provide a sustainable solution to the challenges facing the municipality with regard to the capacity of the works and the prevailing environmental issues associated with Kamfers Dam. The reuse of the treated effluent from the HWWTW was also seen as a water conservation intervention. Also, by utilising the treated wastewater effluent for agricultural purposes the intervention was contributing towards addressing the socio-economic challenges of Sol Plaatje through the creation of commercial farming opportunities for small scale community farmers.

Description

In 2009, the municipality initiated the HWWTW capacity refurbishment and upgrading project. This project comprised technical and social developmental actions. The technical construction part of the intervention involved the installation of infrastructure to discharge effluent into the Vaal River while the social development part of the intervention was being implemented, which included encouraging the use of treated effluent for economically viable projects and the establishment of emerging farmers on irrigable land.

The project included:

1. Diverting the effluent from Kamfers Dam to a balancing tank,
2. Conveying the effluent to Langleg pan and the Vaal River,
3. Making water available to commercial farmers for irrigation, and
4. Establishing emerging farmers on a portion of municipal land utilising purified effluent to irrigate crops.

Results

The diversion of effluent is still in its initial stages and it is thus difficult to evaluate results. It is, however, intended that the use of purified effluent be monitored. The municipality is confident that as the advantages of using this water for both agricultural and industrial purposes becomes known, its use will be accelerated to meet the supply.

Although discussions have taken place between farmers and the municipality, and a draft Memorandum of Understanding between the two parties has been prepared, no final mechanism for the distribution of effluent has been agreed upon.

The use of effluent for emerging farmers has not progressed beyond the conceptual stage. A detailed business plan must still be prepared and potential funders and beneficiaries identified.

Lessons Learnt

These types of integrated projects are complex with many different forms of stakeholders that have to be consulted with which stretches out the timeline and at the same time frustrates interested parties.

The implementation of a project of this nature should identify stakeholders as early as possible in the planning phase in order to prevent any unforeseen events arising during the application stage.

A project such as this requires flexibility in approach, planning and implementation along with alternatives built into the potential options for implementation.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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WATER RESEARCH COMMISSION

T14

SOL PLAATJE LOCAL MUNICIPALITY

DRY SANITATION

Intervention Type	Greywater Reuse
Reason	Scarce Water Resources
Cost	Unknown

The Sol Plaatje Local Municipality, which includes the towns of Kimberley and Ritchie, is located in the Northern Cape and has a population of 245 000 of which 74 000 are indigent. Water supply infrastructure is aging and there is a backlog of the construction of new networks to accomm odate the ever increasing growth in population all of which is contributing to high water losses and wastage.

> "Waterborne sewage systems demand large quantities of water that can be better used for human consumption."
>
> *- Ecosan*

The Sol Plaatje municipal area receives, on average, only 200 mm/year of rainfall compared to South Africa's average rainfall of 464 mm and the world average rainfall of 860 mm. To augment the desperately needed water supply is costly and inhibiting the growth of the area. For this reason, there is a need to move away from augmenting water supplies, and move towards water conservation and demand management (WC/WDM) initiatives which would make capacity available for development, growth and new housing developments without having to upgrade augmentation schemes.

The need for housing in the Sol Plaatje area increases the demand for water as water supply networks are expanded for new housing projects and more people are supplied with water. Ironically these scarce water supplies are used to "transport" human waste by installing mainstream sanitation systems which require large volumes of water from the already stressed water resources.

These wastewater systems also cause pollution which affects the environment as well as human health.

A single person produces about 550 ℓ/year of excreta. When flushed, each person uses about 15 000 ℓ/year of potable water, which when compared with the excreta produced, represents a wastage of water.

Furthermore, in developing countries, 90% of sewage is discharged into rivers and dams without proper treatment. Therefore, alternative methods of providing effective sanitation services need to be found.

The Eco-village pilot project was initiated as a testing site for the implementation of dry sanitations systems in Sol Plaatje area. Later, the Hull Street project was also developed in an effort to build environmentally friendly houses with an alternative environmentally acceptable sanitation solution that would conserve water in a sustainable manner and provide an equitable service.

Objectives

The objective of the project was to test several concepts for low cost, environmentally sustainable housing. Part of the testing included the viability of using dry sanitation systems as an alternative to conventional waterborne sewage systems.

Description of Ecological Sanitation

Ecological Sanitation (EcoSan) is a sanitation process in which human excreta is dealt with in an environmentally friendly way through recycling and as a source energy production and composting.

Urine and faeces contain the three major plant nutrients, namely nitrogen, phosphorus and potassium. These nutrients make human excreta a valuable resource that can be recycled and used in gardens and for agriculture purposes. However to be effective, urine and faeces need to be separated firstly so that the urine can be added to the greywater and used for irrigation and the faeces can be dried for composting.

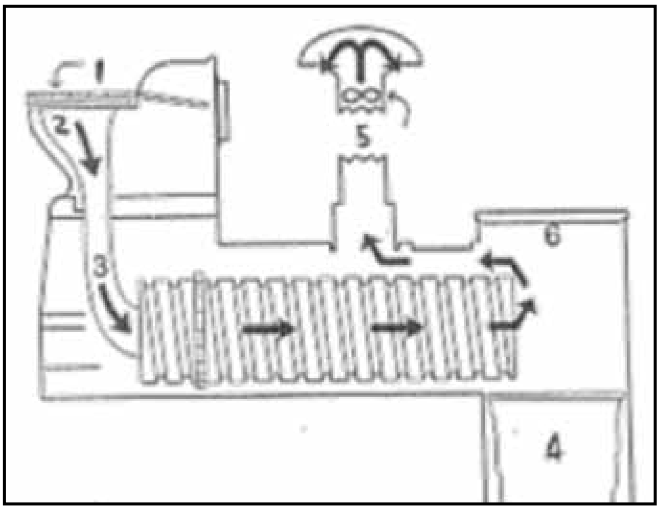

Figure 1: Dry sanitation toilet design (see operation description below)

Each housing unit had a dry-sanitation system installed along with a urine diversion system. This separated urine from faeces as mixing the two produces foul odours created by bacteria found in faeces. The bacteria break down urea and creates a health and environmental risk.

Urine Diversion

Toilets were installed that were constructed with two chambers, allowing for urine to be diverted into the housing unit's greywater pipes and then into the centralised greywater system.

The urine diversion toilet ensures that urine is separated from the faeces in an effort to maximise the effectiveness of nutrients when urine is used as a fertilizer. The urine, along with the greywater, is then used as a fertilizer in gardens and agricultural plots.

The toilet was also constructed with a ventilating system in order to minimise foul-smelling odours and create a liveable environment for the residents.

Recycling of Organic Waste

The second chamber of the toilet collected faeces in a separate plastic bag. Because faeces contain a large amount of bacteria and other pathogens which pose a health and environmental risk, they need to be dried in order to be recycled. The Sol Plaatje Housing Company's (SPHC) maintenance staff removed the bags on a regular basis and then placed the faeces on a composting site. After 6 months, faecal material dries and becomes a fertilizer. It is then used in gardens, agricultural plots or sold to local farmers.

Description of the operation of a dry sanitation toilet:

The human excrement falls down a vertical chute (2) and into one end of a specially designed helical screw conveyor (3). Every time the toilet lid (1) is lifted, a mechanism rotates the conveyor. With each rotation the human excrement slowly moves along, taking approximately twenty five days before falling into a reusable collection bag (4). It takes six months for the bag to fill with dry and odourless waste.

Through the uniquely designed ventilation pipe (5), adequate airflow is provided for the dehydration/evaporation, deodorising process. Human excrement consists of roughly 95% moisture. As the solids dry in the conveyer the urine and moisture is vented into the atmosphere. The solid waste then dries into a compost-like material, roughly 5-10% of its original mass.

Results

There have been 127 housing units in Hull Street, Galeshewe, which have had urine diversion toilets installed. Research found that 85% of the residents were unhappy about the dry sanitation system, with 11% being satisfied and a further 4% being happy with system. The study found that although 68% of residents were satisfied with the living conditions, residents were unhappy about the continuous smell in the house and the unhygienic nature of the dry sanitation system.

Further reasons for the unhappiness surrounding the dry sanitation system are found in Table 1. Those residents who were satisfied with the system indicated that the benefit was that no payment was required for water or sanitation, which according to SPHC would have been R150 per month.

The long term impact of using dry sanitation is a 50% savings in water usage thus reducing extraction levels and conserving scarce water resources.

Table 1: Reasons for being unhappy with the current dry sanitation system in the Hull Street project

Reasons for being unhappy	Number	Percentage
Smelly	78	66.7
Unhygienic	22	18.8
More maintenance required	7	6.0
System not user friendly	6	5.1
Inappropriate for children	2	1.7
Other	2	1.7
Total	117	100.0

Lessons Learnt

Residents and other key stakeholders, such as councillors, should be involved early on in the process with the design and implementation phases so as to mitigate the cost of redesigning and reinstalling systems due to resident dissatisfaction.

Distributing educational information on dry sanitation concerned with health risks and proper maintenance is an important step, especially in the effort to change perceptions around the use of dry sanitation and so that the system works properly and is not a problem.

Project Highlights:

- [ ] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T15

CITY OF CAPE TOWN METROPOLITAN MUNICIPALITY

TREATED EFFLUENT REUSE

Intervention Type	Wastewater reuse
Reason	Alternative means of supplying water in order to conserve potable water resources
Cost	R189 million

The City of Cape Town Metropolitan Municipality (CCT) is home to 3.4 million people with 15% living in informal settlements. This implies that besides the normal expected growth in water demand that the water supply to the city needs to grow by at least 10% to meet the needs of all the residents. Approximately 24 million kℓ/month of water is already abstracted by the city. Of the total water abstracted by the city 25.4% is lost and on average 16 million kℓ/month (66% of the total abstracted) is discharged as wastewater.

At the current growth in population and development the demand for water by the CCT will exceed the capacity of the available water resources by 2017. There is now an urgent need to find alternative sources of water and the CCT has put in place plans to abstract water from groundwater resources, desalinate sea water and reuse treated wastewater effluent.

> "The benefits of wastewater re-use include a reduction in the demand for potable water, quantity of effluent and loading on the environment."

Treated Effluent Reuse

The reuse of treated wastewater effluent is the using of effluent from wastewater treatment plants. The treated effluent from a wastewater treatment plant is normally discharged back into a river or the sea.

This effluent, which is treated wastewater from a sewage treatment works, can be treated to a water quality that is acceptable for the use for which it is intended for such as for the irrigation of golf courses and sport grounds, and for industrial purposes, which include water for cooling towers and electricity generation.

The use or reuse of treated wastewater effluent reduces the volume of water abstracted from natural water resources. From a water demand perspective, by reusing wastewater from sewage works, an alternative water source has been created and the water demand from the municipality has been reduced.

Objective

The capacity of the natural water resources from which the CCT abstracts its water will soon be depleted. CCT have recognised the potential to augment their water supply by using treated wastewater effluent thereby reducing the demand for water to be abstracted from their existing natural water sources.

Description

CCT embarked on a project to augment its water supply with treated wastewater effluent. Customers with high consumption levels of potable water have been approached first. By focusing only on and supplying these users the municipality would be able to achieve a reasonable rate of return on the capital investment and operational costs required for the additional treatment and a dedicated water supply network from the treatment plant to the user.

CCT treats the wastewater effluent to a high water quality standard, although not a potable water quality standard.

Potable water quality standards are for human consumption and although industry also requires a high water quality standard it is based on different parameters. The CCT has avoided the perceptions that wastewater can be used for human consumption and has focused the reuse of the effluent from sewage wastewater plants to other uses (irrigation and industrial use).

Wastewater Treatment plants have since been extended in Belville, Parow and Kraaifontein to supply treated wastewater effluent to these consumers. Currently, the CCT supplies 1 million kℓ/month treated wastewater effluent, during the summer months, and 500 000 kl/month during the winter months to golf estates, industries, sports fields, farmers and the city parks for irrigation purposes and various industrial processes.

Major extensions were also done at the Potsdam Treatment Plant in Milnerton, north of the Cape Town CBD, which included a new intake chamber, two new pump stations, a filtration plant, 4 km pipeline and a 40 000 kℓ storage reservoir. These extensions increased reuse capacity from 375 000 kℓ/month to 510 000 kℓ/month. However, even with these new extensions completed, there is still potential to increase treated wastewater effluent so as to supply 1.9 million kℓ/month of water for reuse to different customers.

Results

The municipality has 10 plants in operation from which a total of 110 consumers are supplied with 1 million kℓ/month of treated wastewater effluent which represents a water savings of 4% of total water supply to the CCT.

In 2007, about 60% of potable water supplied to the CCT was discharged to the CCT's sewer systems as wastewater. Only 10% of this wastewater is then treated and re-used. The rest is discharged to the sea after some treatment. Therefore there is huge potential for the CCT to extend its programme to reuse treated wastewater effluent to supply more consumers and thus realise a greater savings in water and in the longer term cost of augmentation schemes or desalination.

Lessons Learnt

In the planning phases for the identification and supply of treated wastewater effluent to new customers, there must be more effort or focus on ensuring that the public's health and the protection of the environment are taken into account. The cost of the additional treatment of wastewater is high because the water quality requirements of the different users are specific.

In the planning and construction of a new sewage wastewater treatment works, or when a wastewater treatment works is to be extended, additional treatment facilities to treat wastewater to an acceptable standard for water supply, must be taken into consideration.

- [x] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T16

BEAUFORT WEST LOCAL MUNICIPALITY

RECLAIMED WATER

Intervention Type	Wastewater reuse
Reason	Persistent drought leading to severe water shortages
Cost	R24 million

Beaufort West Local Municipality (BWLM) is located in the central Karoo in the Western Cape and consists of the urban town and township of Beaufort West and Kwa-Mandenkosi respectively. The smaller towns of Merweville and Nelspoort are also incorporated in the municipality.

Beaufort West has a population of 41 000 people of which 17 000 are considered indigent. Beaufort West abstracts 41 000 kℓ/month from the Gamka dam and 137 000 kℓ/month from 18 boreholes. Total water losses from bulk and network supply systems have been estimated at 40%.

> "The town's main reservoir, the Gamka Dam, has dried up, forcing municipal officials to introduce a water management scheme."
>
> *- Warda Meyer*

Background

During the late 2000s the Central Karoo region in the Western Cape experienced severe droughts that ultimately resulted in surface water storage dams drying up completely. BWLM was not spared this hardship and the Gamka Dam, representing the main source of surface water for the town, also dried up completely (Figure 1). The situation led to an acute shortage of water for supply to the urban areas, forcing the municipality to implement severe water restrictions. Even these steps were insufficient, and eventually the municipality was forced to supply borehole water via tankers that filled storage tanks located strategically across the town.

Since no natural water resources were available to the municipality to augment supply, the municipality resolved to construct a Wastewater Reclamation Plant with the objective being to reclaim wastewater through appropriate treatment for reuse and supply directly into the distribution network.

Although a worst-case scenario for the municipality, this Case Study presents the experience of the BWLM in reclaiming and reusing wastewater, as a means of meeting the minimum demand of consumers during a severe drought period. The use of this type of technology may find increasing application around the world in the face of climate change, global warming and the increasing severity and length of droughts experienced.

Objective

The objective of this project was to construct a wastewater reclamation plant to provide potable water aimed at meeting the minimum critical demand and thus conserving the very limited availability of surface water to the municipality due to on-going severe drought.

Direct Water Reclamation

The reclamation and reuse of wastewater represents an alternative source of water to a municipality who is unable to meet demand due to dwindling supplies.

Reclamation involves a process in which wastewater is treated to remove impurities, pollutants and pathogens. The end result is potable water of a high standard that meets international water quality requirements and can be used for municipal supply to domestic consumers. The produced water can also be used in agricultural and industrial processes, for irrigation of sports grounds or golf courses, or for the recharge of ground water.

Figure 1: Dried up Gamka dam

Although reclamation of wastewater for reuse in distribution systems is a tried and tested technology, public perceptions over quality and health risks have limited the uptake of these systems around the world. At one stage, only the City of Windhoek in Namibia had a wastewater reclamation plant for the supply of potable water.

Concerns by the general public as to the quality of wastewater treated for reuse as potable water are valid since wastewater contains numerous chemicals, toxins and pathogens which could cause harm if ingested. Thus the treatment of wastewater must follow a rigorous and closely monitored process to protect and safeguard the health of residents.

To win over public acceptance and trust, knowledge relating to the system, the quality of water produced and the safety procedures followed in the production of potable water must be communicated to the highest degree possible to ensure acceptance.

Implementation

A wastewater reclamation plant was built by BWLM at a cost of R24 million. The plant was built to feed treated potable effluent water directly into the bulk water supply network through a 4 km long pipe connected to the municipality's reservoir, where the treated wastewater is mixed with borehole and surface water, to a ratio of 20% treated effluent to 80% water obtained from surface and underground sources.

Figure 2: Louw Smit drinking reclaimed water

The plant first receives water from the municipality's Wastewater Treatment Works which has already been treated to the standards required by Department of Water Affairs for release of effluent water into natural water courses. The wastewater is then further treated to a potable water standard following a 7 step process, which includes processes using ultra violet lights to kill all known pathogens and reverse osmosis to purify water to a quality equivalent to distilled water. The municipality monitors this process closely to ensure that the quality of the potable water produced is of the highest standard.

Results and Achievements

Beaufort West municipality has achieved a milestone in South Africa by being the first municipality to construct and commission a reclamation plant and use reclaimed wastewater for distribution to all users as potable water.
Implementation has ensured that the municipality can maintain the supply of a minimum critical demand for water even during severe drought conditions.
Another important achievement has been ensuring community buy-in and a change in perception of the "toilet to tap stigma" associated with the use of reclaimed water. This was achieved by engaging the community in public discussion and rolling out an awareness campaign that disseminated knowledge on safety procedures followed in treating wastewater, reinforcing the message that reclaimed water is safe to drink.

Lessons Learnt

Amongst the important lessons learnt is that buy-in from employees of the municipality is just as critical as buy-in from the general public.

Employees at the reclamation plant played an important role in influencing the perceptions of their families and friends by taking home bottles of reclaimed water from the plant during the period of severe water restrictions. This allowed their families and friends to warm up to the idea of drinking reclaimed water.

Blending of reclaimed water with bulk water abstracted from natural water sources helped overcome some of the negative perceptions relating to the use of treated effluent water in the supply system. The fact that no one was exempt from receiving the blended water from the municipality also helped allay fears and concerns experienced by the general public.

Proper planning around implementation and commissioning of the plant proved critical to the success of this initiative. Safety considerations were given highest priority during the planning process.

The gaining of an advanced understanding of the technology to be applied was of utmost importance in mitigating production of poor quality water and potential risks involved.

By paying attention to the critical factors highlighted above, the municipality was able to successfully plan, implement, construct and commission the wastewater reclamation and reuse plant, gaining acceptance by townsfolk of the quality of water supplied and thus overcoming the severe water supply constraints in the face of persistent drought.

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T17

CITY OF MOGALE LOCAL MUNICIPALITY
PREPAYMENT METER PROGRAMME

Intervention Type	Installation of a pre-payment metering device
Reason	Non-payment for water usage
Cost	R20 million

Mogale City Local Municipality (Mogale) is located on the western side of the Gauteng Province and is comprised of formal urban areas such as Kagiso, Azaadville, Krugersdorp, Munsieville and Magaliesburg, as well as large peri-urban or rural areas including Muldersdrift, Rietvallei, Tarlton, Sterkfontein, and Hekpoort. The total population is around 320 000, of which 28% are unemployed and do not earn an income. Bulk water purchases from Rand Water and Johannesburg Water amount to 2 million kℓ/month, of which 30% is considered Non-Revenue Water.

> "The reality today is that the issue of water is no longer limited to areas of the third world, but is predicted to soon to be a major concern for people all over the world."
>
> *- Pure Inside Out*

Background

Due to population growth, urbanization, poor water service delivery, a lack of expertise in water management, ageing infrastructure and an entrenched culture of non-payment in especially the previously disadvantaged areas, high water losses were being experienced and revenues from the sale of water were dwindling. The municipality also faced various issues resulting from a lack of metering and inadequate accounting of water volumes supplied to individual customers.

Records for Kagiso showed that only 10% of customers were paying for water consumption and by 1996, unpaid bills amounted to R1.5 million a month. There was a clear and urgent need to address this situation and thus the Municipality initiated the rollout of a large-scale Prepayment Water Metering Programme.

Prepayment Water Meters

Prepayment water meters are an electronic form of metering requiring payment in advance for water by customers. The meter contains a solenoid valve and functions as a dispensing device that is accurately controlled by a pre-programmed algorithm that takes into account a tariff structure, available credit and time of use.

The algorithm can accommodate a rising block tariff and thus allows for the dispensing of a free basic volume of water on either a monthly or daily basis, whichever is the preferred option. This function enables the provision of Free Basic Water (FBW) to customers, including those classified as indigent, whilst also limiting wastage of water beyond the FBW volume.

In effect this technology greatly assists in changing behaviour by transferring ownership of consumption to the consumer and in so doing addresses associated issues such as non-payment and on-property water wastage. The technology also provides a distinct advantage over conventional meters in that the consumer can closely monitor and thus also manage consumption, allowing for purchases of water to be budgeted for.

As a concept and evolving technology, prepayment water represents an effective Water Demand Management tool that can help the municipality in reducing demand, wastage and Non-Revenue Water whilst also helping address non-payment.

The benefits of the emerging prepayment water meter technology were recognized by Mogale City who commenced with the implementation of a large-scale prepayment water project in 1998 involving the installation of an initial 15 000 meters.

Description

Initially, Kagiso was the main area of focus for the installation of the meters, because of the many metering, billing, wastage and revenue collection problems that were being experienced.

A door-to-door campaign was embarked on using Community Liaison Officers (CLOs) to communicate the benefits of prepayment to potential customers and process application forms. This was done in conjunction with a private property leak repair project to ensure that customers were empowered to assume ownership for consumption on installation of the meter. Additional staff were also hired to assist with the various aspects of implementation.

Subsequently the installation programme was extended to all housing areas in the municipality, although the focus has remained on areas where affordability and sustainability of supply are problematic.

Funding for the project has been secured through the Municipal Infrastructure Grant (MIG) programme which has also allowed the municipality to install meters free of charge to beneficiary customers.

Achievements

To date, Mogale City has installed around 30 000 prepayment water meters mainly to residential customers in low-income areas. Meters have also been installed in middle and high-income areas subject to availability and demand. Throughout the project, the municipality has followed a policy of installing meters on demand from existing customers, whilst also stipulating the installation of prepayment meters to all new households. This policy has greatly contributed to the success and acceptance of the project by residents over the past 15 years.

Sustained water savings have been realised in the form of reduced consumption and increased payment levels. Payment for water usage rose from 10% to 95% in Kagiso with congruent water savings of around 500 000 kℓ/month. This represents a monetary saving of about R3 million per month in today's terms. Figure 1 below shows the reduction in water consumption in Kagiso after project implementation.

Currently the municipality sells 120 000 kℓ of water per month via the prepayment water system, representing a revenue stream to the municipality of at least R500 000 per month. This excludes the volume of water supplied in terms of the FBW policy of the municipality.

Acceptance levels in beneficiary communities reached 90%, further reinforcing the success of the project and approach adopted by the municipality. Installation of the water meters has resulted in a positive behavioural and perceptual change towards water use.

The municipality has also achieved savings in various operational costs relating to meter reading, billing and revenue collection.

Lessons Learnt

Important lessons learnt from this project are listed below.

- In order to ensure the sustainability of the system, it was essential to establish systems and processes to address any problems experienced by customers with the installed meter. Field workers and technicians were employed by Mogale City to attend to reported complaints and faults on site, and response included removing the meter in the event of failure. A through-pipe was provided to the property to ensure continued water supply while repairs to the meter were being effected,
- Repair of faulty meters was a lengthy process and resulted in customers receiving free water whilst the meter was being repaired. Additional measures could have been implemented to ensure a shorter turn-around time on faulty meters,
- Metering of customers is critical to ensuring that water supply services remain sustainable and that costs can be recouped from customers,
- Prepayment encourages effective water use and thus savings are realised, which benefit both the customer and the municipality,
- Prepayment is an effective way of dispensing Free Basic Water volumes to especially indigent consumers,
- With the correct approach prepayment tackles the issue

of non-payment and transfers ownership of consumption to the consumer,

- Prepayment enhances the customer's ability to monitor and manage water consumption on private properties,
- Prepayment metering should not be seen as a means to increase revenues, but rather as a means to reduce water wastage and realise savings in operational expenditure, and
- The municipality should ensure that customers can purchase prepayment credits at any time (and especially after-hours) from locally based vendors.

Figure 1: Kagiso consumption

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T18

CITY OF CAPE TOWN METROPOLITAN MUNICIPALITY

WATER MANAGEMENT DEVICES

Intervention Type	Controlled water supply to indigent consumers
Reason	High levels of wastage by indigent consumers
Cost	R400 per unit

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

THIS CITY WORKS FOR YOU

The City of Cape Town Metropolitan Municipality (CCT) is home to 3.4 million people and uses 800 000 kℓ/day of water. The demand for water continues to grow and will exceed the capacity of available water resources by 2017. As part of its water conservation programme, the city has to find solutions to reduce the 19.9% water Non-Revenue Water (NRW). One of the main contributors to these water losses is the indigent households because of their leaking plumbing fixtures and water wastage. Water losses, especially with indigent households, not only represent a waste of an increasingly limited resource, it also has an impact on the city's revenue and the city's capacity to grow and develop. This is further aggravated by the accumulation of non-payment of debts by indigent households and the financial pressure to address the palpable disparities in water supply services between the rich and poor with the indigent households having insufficient access to services.

The CCT drafted a Credit Control and Debt Collection Policy which prescribed and prompted the initiation of an intervention to address the high debt levels and water wastage. The intervention included the installation of water management devices (WMD) in low income households.

> "We forget that the water cycle and the life cycle are one."
>
> *- Jacques Cousteau*

Water Management Devices

A WMD is a device designed to manage water flow, water consumption or the water needs of a residential property or any other property as deemed as needing such a device. The device is connected to the existing household meter and is programmed to supply a fixed volume of water to a household on a daily basis which includes the free basic 6 kℓ/month of water. The device switches on at a predetermined time (every morning) and switches off once the allocated volume of water has been supplied to a household.

If the household uses less than their daily allocated volume of water, the remaining volume of water is then carried over to the next day.

Should residents require, after determining their own consumption needs, an additional volume of water, this water can then be dispensed by the WMD after a request has been submitted to the municipality has been submitted but at a cost for the additional water.

A WMD differs from a prepaid meter in that a prepaid meter can dispense water up to the purchased amount in one day, thus leaving the consumer without water for the rest of the month unless more water is purchased. With the WMD, the free basic 6 kℓ is dispensed equally over the course of the month providing the household with a continuous supply of water.

The device thus has the benefit of encouraging water demand management, with the provision of access to basic water services, but at the same time restraining water wastage from leaking fittings or the misuse of water.

However, installing the device does have a disadvantage in terms of a higher cost implication as compared to a flow restrictor (R10/unit), however it is still cheaper than a pre-paid meter (R1 000/unit). The advantages and disadvantages of installing the device are shown in Table 1.

Table 1: WMD ddvantages and disadvantages

Advantages	Disadvantages
Complies with WS act in terms of flow and pressure	Equipment relatively expensive
Can be adjusted to customer demand requirements	Cost to install
No new metering management system	Negative perceptions
Dispenses free basic water over the whole month in equal quantities on a daily basis	Political resistance
Alerts customer of possible leak if daily limit is reached on a consecutive basis	
Customer cannot exceed allocated quantity	
Uses same management system and human resources as conventional metering	

Objectives

The main objective of the intervention was to assist low income households to only consume the quantity of water that they needed and the additional volume of water that they could afford.

This was in an effort to encourage efficient water usage and provide an affordable approach in the provision of basic water services, as well as limiting water wastage through a controlled supply of water.

Description of the WM Device

CCT made the device available to all residents directing special focus on installing devices on indigent properties at the cost to the city. According to their credit control policy, those households registered on the indigent database would have a device installed for free and if, over a 6 month period, (1) they had their leaks repaired, (2) paid their monthly accounts, and, (3) maintained their monthly consumption within expected levels, they would then qualify to have their water-related debts written off. For those households that did not qualify, their debts would still have to be paid off. Furthermore, all other households not classified as indigent (or having a property value greater than R300 000) would have to pay a once-off fee to have their WM device installed.

Figure 1: Water management device

A central control team has also been appointed by the city to ensure that the devices are properly maintained and serviced and that all issues brought forward by the customer are addressed. Along with this, a 24-hour call centre has been set up to address any emergencies as quickly as possible.
Given the savings benefits that arise both in costs for water lost or not paid for and in the actual reduction of water supplied to the city, the Housing Department now includes the installation of the WMD as a standard requirement with all new housing developments.

Results

It is estimated that more than 55 000 devices have been installed since June 2007. The results have included a behavioural change by most of the residents combined with an improved awareness of water conservation. In some areas there has been a significant drop in the water consumption which enabled the city to waive debts owed by indigent households exceeding R55 million and collect revenue for water consumed going forward. The WMD has brought about a savings of 4.8 kℓ/month/household (indigent households) where the devices were installed, which represents a R1.2 million/month savings for water losses and water consumption not paid for.

Lessons Learnt

The delivery of basic services to the previously disadvantaged is a political and contentious issue. Despite the savings achieved from implementation of the WMD, it has been discovered that some households intentionally reach their daily limit and then report to the municipality that they no longer have access to water forcing the municipality to increase their daily limit to avoid a political confrontation. The CCT is finding that this is becoming a barrier in rolling out the intervention and as a result is counteracting their efforts to reduce and manage water demand.

Educating the community on how the WMD operates, why it is being installed, how it can benefit the consumer and the importance of water conservation and water demand management is an essential step to undertake. Given that delivery of basic services is a political issue, steps taken to educate the community go a long way in diffusing possible future dissensions.

The cost of water wastage through leaks and the subsequent non-payment by indigent households costs the city millions of Rands. Thus, the implementation of other WC/WDM interventions such as pressure management and on-indigent-property leak repair project are important to implement in conjunction with the installation of WMDs. Leak repairs also have the added advantage of preventing on-property leaks from wasting the allocated daily quantity of water thus assisting households to meet their basic water needs as is required by legislation.

Finding common ground and working with the various stakeholders who are affected by the intervention in order to mitigate community opposition and ensure successful implementation is an important step to take.

As a result of installing the devices, a municipality, with the support of the consumer, is able to reduce and manage water consumption through the use of WMDs while still ensuring the delivery of the free basic water as is set out by the legislation.

The setting up of a customer care service centre with a 24-hour call out service for emergency cases allows consumers to report any problems they experience. In addition, a dedicated SMS line has been set up to deal solely with water and sanitation problems.

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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T19

CITY OF TSHWANE METROPOLITAN MUNICIPALITY

ODI INDUSTRIAL METER AUDIT

Intervention Type	Controlled water supply to indigent consumers
Reason	High levels of wastage by indigent consumers
Cost	R400 per unit

Sandspruit Works Association (SWA) currently provides water and sanitation services on behalf of the City of Tshwane Metropolitan Municipality to communities north of Pretoria, including Garankuwa, Mabopane and Winterveldt, as well as informal settlements such as Itsoseng/ Tusaneng, and Kopanong. There are over 47 000 registered account holders or consumers in this area, of which 11 500 are registered on the indigent database.

In terms of the Water Services Act (Act 108 of 1997) SWA is a Water Services Provider (WSP) and is registered as a Section 21 Entity. It distributes 1.8 million kℓ/month of potable water of which 24.1% is considered to be Non-Revenue Water (NRW).

Although industrial consumers in Tshwane use 30% of total water supplied, they represent only 3% of the total number of consumers. It makes good sense therefore to focus on the accuracy of metering and billing arrangements to these customers which helps to reduce NRW whilst also increasing revenue.

> "If we continue at our present rate of water consumption, we could run out of drinking water before 2040."
>
> *- WWF South Africa*

Background

Due to a recurring NRW figure of 54.4% and an increase of 3.2% in the volume of water supplied to the Garankuwa Industrial area, it was decided that a thorough meter audit be undertaken, aimed at locating and identifying meters and connections that were potentially contributing to the high level of NRW and associated loss of revenue. The volume of NRW for this industrial area was quoted as 43 000 kℓ/month by SWA.

Non-Revenue Water

NRW is water that has been extracted, treated and distributed to end-users, and is lost in the water supply cycle. Although there is a significant and quantifiable cost to NRW, no economic or beneficial value is derived from this lost or wasted water. NRW can be broken down into two main components as follow:

- Real Losses (or sometimes referred to as Physical Losses) which include losses such as leaks or burst pipes occurring in the distribution system, and
- Apparent losses which includes losses due to meter faults and inaccuracies, theft of water, unmetered connections, as well as billing and administrative oversights.

Industrial Meter Audits

In South Africa the industrial sector accounts for 27% of total water consumed. Thus it is important to ensure that this sector is metered and billed correctly and users are paying for the water they consume. Conducting industrial meter audits is an important task to undertake as it identifies metering and billing problems and inaccuracies which negatively impact the revenue streams of a the municipality. Results of the audit can be used to rectify these problems and inaccuracies and ensure that industrial consumers are properly metered at all water use points, and that data relating to the consumer has been correctly entered into the consumer database.

Objectives

The purpose of this audit was to undertake an on-site assessment of water connections to establish:

- The condition and accuracy of installed water meters to especially large industrial consumers in the area,
- Establish the existence of unmetered connections including unmetered fire connections,
- Compare on-site meter information against captured database information, and
- Report back on the existence of illegal connections.

Description

The audit was carried out on 180 industrial consumers where meter and consumer data was successfully captured on behalf of the WSP. Six bulk supply meters were located and logged as well as one large consumer meter in order to allow for a more complete water balance.

Information such as meter number, size, co-ordinates and consumer details, including photographs taken on site was captured. Information on fire hydrants and fire connections was also recorded and passed on to the WSP. In addition, information relating to each customer was updated, such as physical and postal address, business name, ownership and contact details.

Additional tasks included the taking of at least two consecutive consumer meter readings over an agreed to meter read period.

Results

By taking remedial action based on the findings of the audit, the WSP was able to reduce the NRW figure to 17% of water purchases, equating to an increase of 30 000 kℓ/month in billed metered water volumes. In addition to a reduction in NRW, the audit produced an updated accurate water balance for the two industrial zones.

Findings from the audit reported to SWA included:

- Leaks on vacant consumer properties where no payment was received for water consumed by the WSP,
- Leaks on network pipes and connections upstream of the consumer meter,
- Incorrect meter sizes, installations and installation positions (Figure 1 represents an incorrectly positioned meter),
- Standing meters and meter under-recording consumption due to age,
- Illegal connections (including incorrect/unauthorized use of fire connections) were photographed and co-ordinates captured and reported to the WSP (Figure 2 represents an illegal connection),
- Unmetered connections, and
- Faulty and leaking network fire hydrants.

The pre- and post-intervention consumption data is shown in Table 1.

Due to the billing department incorrectly allocating some industrial consumers in Zone 15, more water was sold than was supplied to this zone. This accounts for the negative pre-intervention NRW figure recorded for this zone in Table 1. This was rectified through the correct allocation of consumer meters to supply zones.

Table 1: Consumption data

Category	Industrial Zone	Zone 15
Water Sold (kl) (pre-intervention)	36 153	7 248
Water Sold (kl) (post-intervention)	82 860	212
Water Supplied (kl) (pre-intervention)	79 369	7 024
Water Supplied (kl) (post-intervention)	100 165	7 780
NRW (kl) (pre-intervention)	43 216	-224
NRW (kl) (post-intervention)	17 485	7 568
%NRW (kl) (pre-intervention)	54.4	-3.2
%NRW (kl) (post-intervention)	17.5	97.3

Lessons Learnt

Lessons learnt from the implementation of this intervention included:

- Obtaining cooperation from both the technical (metering) and financial (billing) departments of the municipality prior to implementation – sometimes this can be difficult especially if either of these departments are unaware of the planned intervention,
- Approaching industrial consumers with care and consideration as these are usually paying customers and they should be treated with due respect when representing the municipality. However, if a consumer has not being paying or has been under-billed, then the visit by the audit staff can be unwelcome,
- Working off aerial photos of the zones as these are helpful in determining if a site is empty, occupied or encumbered by existing buildings,

- Aligning the audit – especially the reading of consumer and bulk meters – with the monthly meter read cycle of the municipality. This helps tremendously with the water balance and can show immediately if there is an improvement in the level of NRW, and
- Ensuring that information gathered from the audit corresponds with the consumer database and where this is not the case, a process should be instituted to rectify the database. This process ensures that industrial consumers are correctly billed.

Figure 1: Incorrectly placed meter

Figure 2: Illegal connection

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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T20

MANGAUNG LOCAL MUNICIPALITY
METER AUDIT AND REPLACEMENT PROGRAMME

Intervention Type	Meters
Reason	Non-payment of water negatively affecting revenues
Cost	R12 million

The Mangaung Local Municipality (MLM) is the biggest municipality in the Free State and has a population of 752 000 people living in the towns of Bloemfontein, Botshabelo and Thaba Nchu. Demand for the municipality amounts to approximately 169 000 kℓ/day with Non-Revenue Water estimated at 28%. MLM finds itself in a position in which the current average daily water demand exceeds the current sustainable water supply putting pressure on the MLM to implement measures to reduce demand. Due mainly to problems associated with consumer meters which resulted in consumption not being paid for, the municipality was not receiving sufficient revenue to budget for and fund water conservation and water demand management (WC/WDM) interventions. It was hoped that a programme focused on addressing problems related to meters would enhance the collection of revenues.

> "If there is magic on this planet, it is contained in water."
>
> *- Loran Eisley, The immense Journey, 1957*

Reason for intervention

The MLM found that most of the complaints received by the Water Demand Management (WDM) Department were about meters not working and issues concerning the accuracy of accounts. These complaints were laid mostly by consumers who were able to pay for their consumption, however they chose to withhold payment until their complaints were attended to. Thus the municipality was faced with the issue of non-payment for water consumption coming from their main source of income. MLM already faced the problem of non-payment from residents in poor areas due to high water bills as a result of unattended to leaking fixtures on their properties. Clearly, something had to be done to improve the lack of revenue collected by the city. It was then decided that a programme aimed at the proper metering of all properties would be implemented which targeted all income groups.

The importance of consumer meters

From the perspective of the municipality, consumer meters are seen as an important part of any WDM strategy as they provide the platform to bill households for their consumption and collect revenue as a result of payment for consumption. Consumer meters also provide households with an incentive to save water.

This is the case as increased water consumption leads to a higher amount the consumer would have to pay. So with this in mind under normal circumstances, a customer would make an effort to reduce his consumption to affordable levels.

It was with this in mind that strengthened the case to implement a programme based around consumer meters.

Objective

The long term view of the MLM is to have sufficient funds to implement WC/WDM intervention and thus the main objective of this intervention was to enhance revenue collection by rectifying problems associated with meters and subsequently with the billing of consumption and the payment of accounts.

Description

The municipality decided to target all income groups within the municipal area, with a concerted effort being made to identify and register all "indigent" households who were in fact able to pay for municipal services. The Department of Water Affairs (DWA) gave the MLM a grant of R12 million to fund the programme.

An initial audit was conducted by the meter readers in conjunction with their meter reading duties. The meter readers identified and captured meter faults after which they sent a report to the WDM Department who would then ensure that the faults were rectified. Meter readers had to look for those faults which included:

- Meters out of order,
- Meters or meter chambers full of water, soil or plants,
- Leaking meters,
- Meter faces which had mist, and
- Unmetered connections.

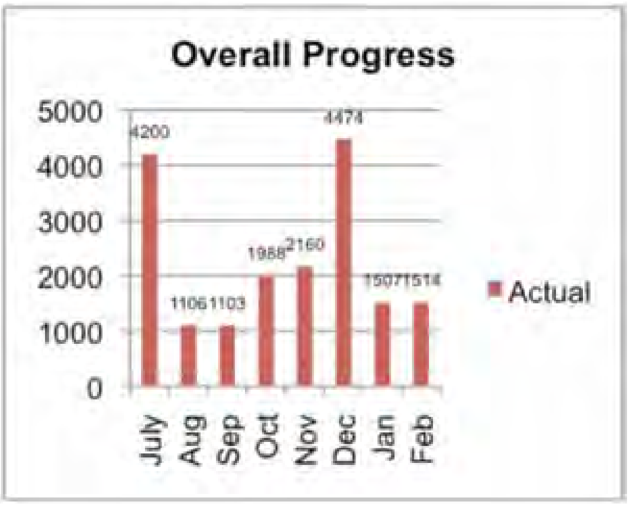

Figure 1: Progress Made

An MLM-appointed maintenance team was then sent out to perform the repairing and replacement of meters. This team was also required to fix any mains pipe leaks that were found. But due to the work load, the municipality appointed 4 contractors to assist with the maintenance team.

To address the issue of non-payment, the MLM also established measures to help it meet its overall objective of enhancing revenue. Given that a customer did not pay for their consumption, the MLM would use the following process:

- A follow up was done to verify that the meter was still in good working condition. If so, a flow restrictor would be installed,
- If it was found that the flow restrictor was tampered with after installation, the household owner would receive a penalty of R3200, and
- If it was found that if the flow restrictor was continuously tampered with, the water supply to the property would be cut off.

Results

The municipality has been making steady progress in rectifying meter faults. Between the period of July 2010 and March 2011, over 18 000 identified meter faults were rectified, with the majority, 17 000 faults, being rectified in Bloemfontein. Figure 1 below shows the overall progress made by the city.

This has led to improved revenue collection by the city due to increased billing which is shown in Table 1 below. The table shows the revenues collected from the sale of water between the years of 2009 to 2011. Revenues have increased by 26% during the period or by a value of R107 million.

An analysis done on 20 000 metering faults found that 1 165 kℓ/month was being lost at a cost of R10.6 million. It was determined that the municipality could save R1.9 million if these faults were fixed (R10.6 million less 8.7 million to rectify meter faults). It can be seen that a large amount of water and cost would be saved if these faults were addressed.

Table 1: Revenues Collected from the Sale of Water

Year	Revenue (R)
2011	406,241,759
2010	303,100,248
2009	298,983,289

Challenges

The WDM department was finding it difficult to raise sufficient funds to roll out this intervention on a full scale in the areas of Botshabelo and Thaba Nchu. Rolling out the intervention in Bloemfontein was also affected. Adding further strains to their current budget, additional aged pipes were being located which needed to be replaced.

Lack of communication and cooperation between the Finance Department and the WDM Department was proving to be a barrier affecting intervention progress. This was also having an added impact on progress as updated customer information was being given to the finance department however not being updated on their billing system.

This was compounded by the maintenance team not sending information on completed meter replacements and leakages repaired. This included:

- Who made the repair/replacement,
- When was it done, and
- What was the serial number on the meter repaired/ replaced.

This was creating further backlogs in updating the customer database. The net effect was that the MLM could not bill the full amount of revenue for their efforts made in implementing the intervention.

The initial need to appoint contractors was due to a lack of labour and other resources within the MLM to deal with the workload. However, problems were experienced after the contract was drafted and signed as oversight in drafting the contract paved the way for abuse. This included:

- Abuse of emergency rates by contractors as they concentrated on emergencies more than normal cases, hours claimed were excessive and no supervision could be provided by the employer's representative,
- Abuse of the transport charge rate as no thresholds were set for maximum kilometres to be travelled by the contractors when attending to complaints,
- Abuse in terms of claiming materials which were not related to the implementation of the intervention, and
- Non-compliance with Occupational Health and Safety regulations by the contractors.
- The WDM Department also found that new meters were being damaged as they were not being installed properly. MLM thus organised training for community members, who were then employed by the contractors.

Lessons Learnt

- Sufficient human resources with the necessary technical skills are needed in order to implement this intervention,
- The proper drafting of the tender document and construction drawings are critical in terms of managing risk from the onset, and
- Full time supervision on site by the MLM is critical during project implementation to ensure that contractors adhere to stipulations provided by the city.

Project Highlights:

☑ Verified Savings	☑ Cost Effectiveness
☐ Behavioural Change	☑ Replicability
☑ Political Endorsement	☑ Scalability
☐ Capacity Built	☑ Employment Opportunity
☑ High Level Management	

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FINANCIAL INTERVENTIONS

In terms of the delivery of water and sanitation services at a municipal level, a strong link or relationship exists between water demand management and financial management.

Typically, the better delivered services are managed in terms of metering, billing and revenue collection functions, the lower the demand for water will be and the need to intervene or change the status quo.

By implication then, financial interventions can be extremely effective in reducing excessive water demand and any Water Conservation/Water Demand Management (WC/WDM) programme implemented by a municipality should focus on financial issues such as tariff formulation and structure, meter reading, financial management and enhancement, accuracy of billing and metering data, asset management, and even credit control.

A distinction needs to be drawn between enhancing revenue and increasing revenue. Although it is recognized that price elasticity applies to the supply of water, the management of demand does not necessarily mean that the cost of water should be increased or that the amount of revenue collected must be increased. Rather inefficiencies in the system should be focused on and reduced which can greatly help in creating a more cost-effective service delivery environment. In most municipal systems much scope exists to reduce inefficiencies such as water wastage, water losses and other components of Non-Revenue Water (NRW) such as unauthorized consumption. Only in extreme cases where it is imperative that demand be reduced (such as in a drought situation), will it be necessary to increase the cost of water as a type of punitive measure aimed at reducing demand.

Almost all documented case studies in the compendium have a financial component to them. Some intervention types such as prepayment metering have both a technical and financial intervention component to them. Case studies that involve purely a financial intervention implemented by the treasury department of the municipality have been included in this section of the compendium. These include a case study on step tariffs, asset management, economic ev aluation and reducing NRW in affluent areas.

F01

EKURHULENI METROPOLITAN MUNICIPALITY

ASSET MANAGEMENT

Intervention Type	Creation of an asset register to manage assets
Reason	Neglect of existing assets led to asset failure, maintenance backlogs, water losses and interruption of services
Cost	R2.5 million

The Ekurhuleni Metropolitan Municipality (EMM) is home to 2.7 million people and has adaily demand of 900 000 kℓ with an estimated Non-Revenue Water (NRW) figure of 38.9%. The city has over 10 000 km of pipes supplying more than 841 000 consumers with an estimated replacement value for its immovable assets amounting to R83 billion. Since 1994, there has been a government imperative to extend infrastructure services to previously unserviced areas thus municipalities have been undertaking massive expansion programmes over the past 10 years to meet this objective. Much has been done in terms of providing communities with access to water, however this has come at a cost since the shift in focus has led to the neglect of existing infrastructure assets and the creation of severe maintenance backlogs.

Like other major metropolitan municipalities in South Africa, failure of infrastructure assets is one of the main contributing factors to water losses in the city. In 2010 the city estimated that the cost of water losses amounted to at least R327 million. This has affected especially townships and informal settlements in the EMM as ageing infrastructure has led to the interruption of water services.

"11 of 19 water management areas in SA have water supply problems."

- WWF South Africa

It was with this in mind that the city decided to implement an electronic-based asset management system which would help with its objectives of providing access to water services without neglecting the appropriate management of existing assets.

Asset Management

Asset management is an effective tool in providing management support for the maintenance and refurbishment of existing assets and the replacement of dilapidated assets or assets which have reached the end of their useful life. Key principles in asset management are environmental sustainability and financial viability. Which need to be taken into consideration when decisions are being made concerning the management of assets.

There are two components needed to manage assets:

- An asset register which consists of a list of assets owned by the municipality and their monetary values, date of purchase as well as the condition of the asset, and
- An asset management plan which sets out the required objectives in utilising assets and the tasks that must be performed in order to meet those objectives.

Asset management plans ensure that municipal officials take into account the acquisition, operations and maintenance, refurbishment and disposal of assets which are needed to meet service delivery requirements. Furthermore, it helps with developing a business case in order to gain authorization from internal and external stakeholders to fund maintenance or purchasing activities.

The advantages of keeping an extensive up-to-date asset management system strengthens financial management and supports municipalities in addressing infrastructure backlogs and capital expansion projects. Financial management is assisted by providing information on the time frame of disbursements and its monetary value thus making it possible to plan in advance for the budgeting of future asset purchases.

Furthermore, because sustainability is a key principle in the asset management process, another advantage is that the impact on the environment can be mitigated through proper planning. An example would be replacing a water main before it reaches its useful life span thus eliminating the risk of a pipe-burst which thus preserves water.

Alternatively, if municipal assets are not properly managed and maintained, the municipality risks its infrastructure deteriorating and becoming obsolete leading to an interruption of services and wastage of water. Rectification then becomes an expensive exercise to undertake and costs can escalate into billions of Rands. Given the political nature of service delivery in the country and the lack of services that exists in impoverished areas, interruptions in service delivery usually lead to community dissatisfaction and unrest.

The advantages and disadvantages of implementing an asset management system are shown in Table 1.

Objectives

The EMM wished to improve the management and maintenance of their assets in an effort to provide services to communities in a financially viable and sustainable manner through the implementation and use of an asset management system. This was important in terms of mitigating unwanted and costly water wastages, addressing the backlogs in infrastructure development and providing water services to communities.

Description

The EMM had an electronic-based asset management system set up at their municipal offices. This system included the asset register which listed the infrastructure assets owned by the municipality including the assets needed to provide water services.

Implementation of the system began in 2009, starting off with an initial investigation to identify and assess the condition of these assets so that a depreciated replacement cost valuation could be performed.

Table1: Advantages and disadvantages of implementing asset management

Advantages	Disadvantages
Social Stability, public health and dignity	Community dissatisfaction and unrest
Stimulation of local economic development due to good infrastructure development and maintenance	Reduced local economic development
Good maintenance of Wastewater Treatment Plants mitigating the risk of untreated wastewater flowing into rivers and dams	The failure of water and sanitation assets leading to increased health and environmental risks
Prevents costly infrastructure asset repairs and replacements	Costly repairs or replacement of dilapidated infrastructure
Leakages causing massive wastage of water is less likely	Assets failure leading to service delivery interruptions

The induction of the Generally Recognised Accounting Practices (GRAP), which requires each municipality to provide a detailed and comprehensive infrastructure asset register, meant that the EMM had to indicate the asset's location, key attributes, condition and value amongst other pertinent information on their asset register. Further tasks included cleansing of asset data, filling of data gaps using projection tools or calculations, as well as evaluating the data in order to determine the current status of each asset. The municipality set up a maintenance fund of 2% in the 2007/08 financial year to ensure that water infrastructure was well maintained. The fund was used for minor upgrades and improvements of the water network.

Results

Asset management has helped the EMM to manage and maintain infrastructure assets and assist municipal officials in undertaking critical planning functions such as required maintenance, replacement and/or expansion of logged assets.

Results have included the implementation of pressure management in selected areas in the EMM, which has been supplemented by the regular maintenance of the pressure management components to ensure continued functioning and water savings. An assessment has also been conducted on the city's steel pipes to determine which pipes needed cathodic protection to prevent corrosion and subsequent pipe failure. Finally, in areas were potable water pipes were still located in a midblock position (i.e. in the back of properties), these have been relocated into road reserves to provide easier access to the distribution network, allowing for maintenance and repairs.

This combined approach, the use of the asset management system and the subsequent implementation of interventions, has helped mitigate and reduce potential water wastage resulting from the failure of infrastructure. This has been accompanied by an improvement in the provision of water services to communities.

Table 2 shows the targets set by the municipality to reduce service interruptions, and what has been achieved over the target period. As can be seen, the municipality has achieved their targets.

Table 2: Target dates

Description of Target	Year Target	Target Achieved
Failure/unplanned interruption of service [Interruptions exceeding 48 hr]	25,000	14,211
Failure/unplanned interruption of service [Interruptions exceeding 24 hr]	30,000	22,531

Lessons Learnt

Proper asset management practices require the regular upgrading and eventual replacement of infrastructure, which also implies a major capital requirement and access to infrastructure information.

However, obtaining accurate data for all the water assets owned by the municipality is a major obstacle that, in some instances, cannot be overcome. Thus it is important to put in place a well-prepared systematic approach in order to coordinate activities to retrieve as much information as is possible.

Furthermore, it is important to keep an up-to-date asset register through the regular assessment of infrastructure assets. This provides important information on the asset's condition and aids in improved management of current or impending asset failure which leads to water losses and service delivery interruptions.

For its asset management system to be effective, the EMM found that the lack of cooperation between the financial department, senior managers and the technical staff needed to be addressed to ensure that no barriers existed in getting information and funding for the maintenance or purchases of assets. They found that without effective communication and decision making procedures in place, implementing any maintenance or replacement programmes were delayed.

Project Highlights:

- [ ] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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F02

CITY OF CAPE TOWN METROPOLITAN MUNICIPALITY

ECONOMIC EVALUATION OF WATER CONSERVATION/WATER DEMAND MANAGEMENT

Intervention Type	Planning
Reason	Evaluation of costs of water Augmentation vs. water conservation
Cost	Unknonwn

The City of Cape Town Metropolitan Municipality (CCT) is home to 3.4 million people with a daily demand of 800 000 kℓ of water. With the current growth of the city, increasing demand for water is going to exceed the available capacity of the existing water resources by 2017. For many years the primary focus of water resources planning in South Africa has been focused on the augmentation of existing water supplies by building bigger water transfer schemes. Only recently has the importance of Water Conservation/Water Demand Management (WC/WDM) interventions been taken more seriously as an alternative to supplementing existing water supplies. Therefore, the evaluation and cost-benefit techniques and processes to determine the full impact of augmenting water supplies against WC/WDM interventions is still evolving and needs more focus and development so as to become recognised and implemented as a proper evaluation process.

> "Water has become a highly precious resource. There are some places where a barrel of water costs more than a barrel of oil."
>
> *- Lloyd Axeworthy, Foreign Minister of Canada*

Economics of WC/WDM

As the capacity of water resources in South Africa is reached and even extended, the scarcity of the water will drive up costs of raw water provision. New otherwise additional available water resources are further and further away and larger water schemes have to be invested in and built. Alternatively, high-tech costly options such as the treatment of wastewater for recycling or desalination have to be considered. These options are expensive and the end-user will need to repay the investments made to supply this water. The challenge of water resource planning now has to focus on ensuring that the higher cost options for water provision are delayed for as long as possible or even totally avoided. DWA has calculated that the total opportunities for reducing water demand in the water services sector (within municipalities) in South Africa is approximately 39% of the total existing demand for water.

Constraints to the Implementation of WC/WDM Interventions

Albeit WC/WDM interventions, as an alternative to abstracting additional water for the augmentation of water supply, are the most logical management plans for municipalities to implement, there still are constraints:

- Financial: Although the economic benefits of WC/WDM interventions are obvious, Water Services Institutions (WSI) have massive financial constraints and more often than not do not have the available capital to invest in the proposed WC/WDM intervention,
- Inappropriate planning practices: Planning focus on traditional supply side management and most of the water industry promote the development of new supply-side infrastructure,
- Political Perceptions: Politicians are focused on the more aesthetically pleasing delivery of new infrastructure such as new dams, water treatment works or desalination systems and not on the more dedicated invisible actions such as leak repairs or greywater reuse,

- Lack of Integration: The different departments within municipalities and between local, provincial and national government are disorganised and there is a lack of co-operation and support. Different departments focus on their mandate and jealously protect their own initiatives,
- Institutional development: The complex institutional arrangements, particularly for the water services in the bigger urban areas, make it difficult to integrate the planning of the entire water supply chain. The lack of clarity and definition of responsibilities of the functions and roles of the various institutions remain a problem,
- Debts: The increasing burden of debt in municipalities because of the low level of payment for services, often as a result of high unemployment and high levels of indigent households,
- Lack of ring-fencing of water services functions or lack of integration and co-operation within the different departments of Water Services Authorities,
- Existing planning practices that chose the cheapest solution in implementation without regard to subsequent operating and running costs. Such practices are prevalent in the building of 'low-cost' housing where cheap toilets and taps are installed that waste water because the connections are sub-standard and the fittings break easily,
- The perception that WC/WDM is only a drought relief mechanism and municipalities often only focus on these interventions when the water resources are critically low,
- Lack of understanding of principles, scope and the potential of WC/WDM interventions as a strategic management tool,
- WC/WDM strategies are often perceived and implemented as a punitive measure against consumers,
- Water Service Providers lack the knowledge and understanding of the consumer and water usage patterns including the drivers which are causing water demand growth,
- Lack of appropriate information and information systems,
- Lack of appropriate WC/WDM planning tools and guidelines available in South Africa,
- Lack of political will and commitment by a number of councillors and key role players in the water services industry,
- WSIs focus on other challenges and WC/WDM is not perceived as a priority, and
- Lack of adequate expertise and knowledge on WC/WDM measures and principles in the water services industry.

Economic vs. Social

Water can be viewed as a social or an economic good. The perspective or focus of WC/WDM as an economic or alternatively as a social good, can a have a profound influence on the implementation (or not) of WC/WDM. Viewing water purely as a social right implies that all members of society have a right to a supply of water but if water is viewed purely as an economic good, this implies that you only have access to water if you are able to afford it and water is merely another resource to be allocated according to market forces.

Taken to the extreme, the purely economic approach concludes that all water consumption should be subject to WDM through measures such as tariffs; however, the pure social approach concludes that very little, if any, water should be subject to these kinds of measures to limit or control supply.

The National Water Act, 1998 (Act 36 of 1998) looks to balance the importance of Social and Economic factors with the necessary environmental considerations without one factor unfairly out-weighing another.

Types of Economic and Financial Evaluations of WC/WDM Interventions

There are a number of different approaches to the evaluation of WC/WDM as part of the bigger consideration of supplying water worldwide. These different types of evaluation processes try to take WC/WDM into consideration not, specifically, as an alternative but as one of the options of ensuring a sustainable cost effective water supply mechanism.

1. **Cost-Benefit Analysis (CBA):** CBA is still one of the most popular of the evaluation techniques. CBA as applied in the public sector in a decisions procedure for:

- Measuring the gains and losses to individuals, using money as the measuring rod of those gains and losses, and
- Aggregating the money valuations of the gains and losses of individuals and expressing them as net social gains or losses.

CBA is a technique that can be used to determine the relative merits of alternative projects in order to reach a high degree of economic efficiency in the application of funds.

2. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation: In 1983, the U.S. Water Resource Council published 'Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation

Studies' to guide the evaluation of all types of potential water related interventions. In 1985 Polhemus, developed a handbook specific for the evaluation of water conservation interventions for the Institute for Water Resources of the U.S. Army Corp of Engineers. These handbooks included broad guidelines on analysing all aspects relevant to the evaluation of water supply interventions including financial, economic, environmental and social aspects.

Four of the 16 steps of the evaluation process in these guidelines focus on assessing the impact of WC/WDM interventions to:

- Assess advantageous effects. These are the indirect impacts including aspects as the advantages to the water system users including possible reduction in costs and energy savings,
- Assess the disadvantageous effects. This time the negative indirect impacts, amongst other effects, such as lost satisfaction and inconvenience related to the use of water with the implementation of WC/WDM interventions,
- Assess foregone supply costs, mainly treatment and distribution costs such as future capital costs and costs that impact on groups or individuals other than suppliers and users, and
- Assess foregone National Economic Development benefit of water supply schemes changes as a result of the proposed WC/WDM such as the difference in size of the water supply scheme.

Once the impacts of WC/WDM interventions on the National Economic Development have been assessed and presented as impacts per unit of water conserved, they are combined with mainly social acceptability and environmental considerations in order to prioritise proposed interventions based on a ranking of all considerations.

3. Organisation for Economic Co-operation and Development Guidelines: Organisation for Economic Co-operation and Development (OECD) published Water Resource Management: Integrated Polices with a cost benefit analysis for WC/WDM showing broad guidelines as to what should be included under benefits and costs.

Benefits include direct and indirect benefits. Direct benefits are, for example, if there is a lower trend in the expected future demand for public water these costs include lower current operating costs and future capital costs deferred or abandoned for new supply projects and treatment of effluents. Indirect benefits, could include, reduced resource commitments on goods and services complementary to the water services.

The guideline identifies four types of costs:

- The present value of the resource costs incurred by the utility responsible for the measure and by any other water agency. This means that a reduction in flow could include the cost of flow reduction valves and an increase in concentration of the wastewater increasing treatment costs,
- The present value of any 'useful' consumption of water services foregone as a result of the intervention implemented. This means the consumption that was of value to the user is now prohibited or because of a change in tariff is voluntarily foregone,
- The present value of any extra resource costs borne by water users for example time and costs of installing WC/ WDM devices,and
- The present value of any resulting external costs borne by persons or groups other than the suppliers and user of water services.

4. United States Environment Protection Agency guidelines: United States Environment Protection Agency (EPA) WC/WDM planning guidelines recommends the following 9 steps:

- Specify WC/WDM goals,
- Develop a water system profile,
- Prepare a demand forecast,
- Describe planned facilities,
- Identify WC/WDM interventions,
- Analyse benefits and costs,
- Select WC/WDM interventions,
- Integrate resources and modify forecasts, and
- Present implementation and evaluation strategy.

The final selection of the proposed WC/WDM intervention includes detailed consideration of as many factors as possible including:

- Programme costs,
- Cost-effectiveness,
- Ease of implementation,
- Budgetary considerations,

- Staff resources and capability,
- Environmental impacts,
- Ratepayer impacts,
- Environmental and social justice,
- Water rights and permits,
- Legal issues and constraints,
- Regulatory approvals,
- Public acceptance,
- Timelines of savings, and
- Consistency with other programmes.

5. Macy and Maddaus: Macy and Maddaus developed a straightforward 9-step approach:

- Multiply the total service area by the WC/WDM intervention's market penetration to give an indication of how many people will be affected by the proposed WC/WDM intervention,
- Multiply the affected population by the WC/WDM intervention's unit savings to determine total water savings per proposed WC/WDM intervention,
- Multiply the affected population by any other savings, such as energy, to determine total other savings per proposed WC/WDM intervention,
- If the WC/WDM intervention saves exterior water, multiply the total water saved by the cost of water (i.e. saved supply and distribution costs),
- If the WC/WDM intervention saves interior water, multiply the total water saved by the sum cost of water and wastewater (i.e. saved wastewater infrastructure costs),
- Multiply total other savings (e.g. energy) by their unit costs to come up with total costs savings,
- To determine the annual costs to the customers as a whole, multiply the affected population size by the annualised costs to the individual customers,
- The costs to the utility are the equivalent, uniform annualised costs determined in the section on developing the WC/WDM intervention's database, and
- All costs and benefit data, including water savings, should be combined into one table for evaluation.

6. Sydney Water IRP Case Study: Financial and economic evaluation again took the form of cost-benefit analysis in the formulation of Sydney Water Integrated Resource Plan where proposed WC/WDM interventions were selected based on criteria that included:

- Cost to the community (Sydney Water and Customers),
- Ability to provide a timely reduction in demand,
- Certainty about costs and benefits,
- Balance across consumer sectors,
- Equity between customers with differing economic circumstances, and
- Balance across option type (Pricing, education, incentives and regulation).

Objectives

The CCT is faced with its water demand outstripping the available water resources by 2017 and with every drought the demand exceeds the storage capacity. In 2000, the CCT was once again faced with the need to find solutions that would address the demand, either by finding new sources of water or reducing the demand from the customers. A comprehensive IWRP was developed with WC/WDM intervention options as part of solutions to be evaluated against traditional supply side water augmentation options.

Description

The CCT Integrated Water Resources Plan (IWRP) was one of the first and most recent IWRP processes completed which included both WC/WDM and supply augmentation options. Also the CCT is responsible for water services in Cape Town. The CCT in the context of a growing demand for water and anticipated prolonged drought initiated an IWRP to find options to manage water demand. The IWRP was based on a Multi Criteria Decision Analysis (MCDA) process which allowed for comparisons of options based on all criteria considered relevant. The financial and economic criteria (amongst the engineering, environmental, social, etc. criteria) were analysed within the process using Cost-benefit Analysis tools.

The MCDA process must be seen as one of many iterative steps of the IWRP. In other words the IWRP would be reviewed and refined further on a regular basis. Further the MCDA is applied as a "process" and a "methodology" that provides a consistent review of different alternatives which impact differently on the outcomes of the review based on a number of different criteria. The evaluation of each option is given an overall score after totalling the scores based on the evaluation of each individual criterion. In this way options could be evaluated comparing individual criterion or the overall scores and depending on the level of importance of each specific criterion the value of the criterion is weighted more heavily if more important.

The MCDA process in the CCT was driven by a combination of the authorities and experts working together. The experts scored specific criterion for which they had specialist knowledge of the criterion and authorities focussed on the weighting procedure of the criterion which were political in nature as required by the prioritisation of criteria in the decision making process. The public would be consulted through the presentation of the final report.

The evaluation process was developed during the initial meeting with the project team and followed with a series of expert panel workshops. In this process the following alternatives were considered:

- Eerste River diversion,
- Lourens River diversion,
- Cape Flats aquifer,
- Pressure control,
- Leakage repair,
- Water efficient fittings,
- Private boreholes,
- Use of grey-water,
- Treated sewage effluent for commercial irrigation (exchange with irrigation schemes),
- Treated sewage effluent for local urban irrigation schemes and industrial use,
- Adjustment of tariffs, credit control and metering, and
- User education.

The following criterion groups were used in the MCDA framework:

- Yield and technology,
- Financial,
- Socio-economic,
- Political, institutional, public acceptance and buy-in, and
- Natural environment.

The options were scored on a 0-100 scale, and a simple weighted aggregation was used:

$$V_k(A) = \sum_{i=1}^{n} w_i\, v_i(A)$$

Where $Vk(A)$ is the aggregated value of option A for criterion group k, w_i is the weight of criterion i and $Vi(A)$ is the score of option A for criterion i.

Results

The initial preliminary conclusions or outcomes of the MCDA process were:

- Pressure control, user education and replacement of automatic flushing urinals presented themselves as obvious priorities for implementation. None of these were controversial, required extensive finance and could be implemented within a short period of time. Leakage repair and use of treated effluent for sports fields were added to this group because they were already being successfully implemented,
- Treatment of sewage effluent for use as potable water was ranked last and was considered as requiring extensive research and review, None the less the yield from this option was ranked as potentially significant. The promotion of greywater and private boreholes also ranked low – these options were, however, related back to a private initiative and were seen as options that would become more popular as the cost of water gradually increased. The swap between treated sewage and irrigation schemes also scored very low,
- An improvement of the management of water services was seen as an action that would result in significant water savings and this included tariff rationalisation, credit control, zone metering and an improved water loss management actions,
- Of the standard supply options the Lourens River enjoyed a slight edge over Eerste River and Cape Flats Aquifer, and
- The implementation of a subsidised retrofit programme should be investigated further.

Lessons Learnt

Public consultation was not part of the MCDA process. Experts specialising in the analysis of specific criterion were given opportunity to give input towards the scoring of the criteria.

Politicians and authorities were given the opportunity in specifying the weight of criteria depending of the priorities of the criterion in the government's decision making process. The public would only be consulted on the final outcomes. This could be seen as a fundamental error in the "decision-making process".

The MCDA process was considered a success and participants were pleased that the process facilitated the practical inclusion of aspects in the decision making that may have been ignored under normal decision making processes within the CCT.

The MCDA process was seen as allowing for a structured evaluation through the use of scores and weights, albeit many of the participants were experiencing the MCDA process for the first time.

However, the process was seen as too time consuming even though it was acknowledged that the comprehensive nature of the process was one of its major advantages. A counter argument was that this was because participants were not familiar with the process and was not because of the process used which was considered as not being a complex one.

One of the main goals of the IWRP process was to generate information on the likely efficacy of WC/WDM interventions and the lack of information thereof remains the main constraint for the successful evaluation of the different WC/WDM options. The value for money of a particular WC/WDM intervention is lacking which makes it difficult to evaluate against the generally easier to estimate efficacy of the supply side options.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [ ] Scalability
- [ ] Employment Opportunity

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WATER RESEARCH COMMISSION

F03

EMTHANJENI LOCAL MUNICIPALITY

STEP TARIFFS

Intervention Type	Financial
Reason	Need to save water and further required by DWA
Cost	Estimated to be R50 000.00

Emthanjeni Local Municipality (ELM) is located in the Northern Cape and comprises the towns of Britstown, Hanover and De Aar and is home to 33 310 people. Like other South African municipalities, Emthangeni is facing a situation in which water demand will outstrip the capacity of its natural water resources. Therefore water conservation and water demand management (WC/WDM) interventions need to be implemented at the local level to prevent a national crisis which is already occurring in many municipal areas.

However, the issue remains of providing water supply to all communities especially in areas where no such services exist which incorporate the principles of affordability, financially viability for the implementing agent and most importantly encourages environmental sustainability. In 2001, one of the mechanisms the National Government introduced was a rising step tariff system with the view of balancing the equity of water supply through creating affordable access to water services for all, financial stability of municipalities through the recovery of essential costs and a WC/WDM intervention through effecting a behavioural change in water consumption in order to achieve a sustainable water supply.

> "Water is the driving force of all nature."
>
> *- Leonardo Da Vinci*

Given its mandate to comply with national regulations, the Emthanjeni Local Municipality drafted a step tariff policy following the then Department of Water Affairs and Forestry's (DWAF) guidelines on norms and standards for water services tariffs.

Rising Block Tariffs

Rising Block tariffs are fees charged to different customer types such as domestic and industrial consumers on an increasing tariff scale for municipal services. This means that the more water a customer uses the more the additional water consumed will cost.

Rising block tariffs thus categorise water users into groups (called blocks) of low, normal and luxury water consumers, charging each group a higher tariff for additional water consumption or as the level of their water consumption increases.

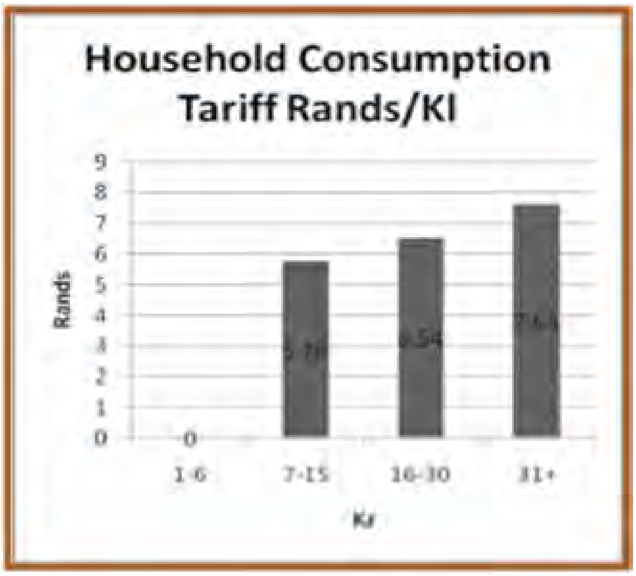

Figure 1: ELM tariff structure

This enables the Water Service Provider (WSP) to provide a service at affordable rates for low income groups while the WSP is ensured financial stability through higher income groups who utilise more water and accordingly pay for their consumption. Finally the higher tariff rates discourage high water consumption.

According to the Water Services Act (Act 108 of 1997), the first block tariff for low water consumers should be set to the lowest possible monetary value in order to meet the Government's objective of providing basic levels of water services to all South Africans. A municipality is legally required to provide a minimum of 6 kℓ and up to a maximum of 10 kℓ/household/month. These volumes are deemed acceptable service levels which are financially maintainable and will ensure an ecological sustainable supply of water from the available water resources and for the provision of all future water supply.

All proceeding block tariffs are then considered to be normal consumption based on average monthly household consumption which is calculated in consultation with consumer representatives (Water Services Forums). Any consumption that is over and above the average monthly household consumption is considered luxury consumption and categorised in a higher end block were the tariffs are set to reflect the cost of augmenting the water supply capacity in order to meet this demand. An example of a block tariff structure is shown in Figure 1.

Objectives

ELM's objective was to comply with the provisions of Section 74 of the Municipal Systems Act, 2000 (Act 32 of 2001) with the aim of creating equitable access to water at affordable rates for basic water supply, regulate water demand in an effort to affect behavioural change while at the same time recovering costs (Figure 2) for the supply of water from point of abstraction to the delivery of water to customers.

Minimum tariff to cover:

- Cost of raw water or bulk potable water, plus
- Cost of overhead and operational costs, plus
- Cost of capital, plus
- Cost of replacement and refurbishment and extension, minus
- Subsidies (refer to Regulation 3).

Figure 2: Minimum Tariff Constraints

Description

ELM put a tariff policy in place which set different tariffs for different water uses which included household and industrial activities. The Municipality structured its tariffs in accordance with national regulations and adjusted certain parameters such as the basic water quantity per household, tariff rates for normal and luxury water consumption and the kilolitre (kℓ) range for each tariff block.

Tariffs were calculated to ensure that ELM remained financially stable especially in ensuring its costs were covered for providing water to consumers, and a premium was added to discourage excessive water use. Making allowance for the free basic water to be supplied to all households, the Municipality also set within the tariff structure a subsidy to recoup the costs of providing the basic free water. Having installed meters for all customers, the Municipality included indigent households in the household tariff structure.

Achievements

The Municipality now has around an 80% payment level for water services, and through a study done post implementation, it was found that a large number of indigent households where using below their quota of 6 kℓ per month. The implementation of block tariffs contributed significantly in the effort to save water in the area, with consumption decreasing by 5.5%.

Lessons Learnt

As a result of putting in place increasing step tariffs, the municipality has experienced its biggest water savings. The step tariffs have effected behaviour change towards water conservation and consumers are more wary of how much water they are using. This has gone a long way in ensuring a sustainable water supply for the Municipality.

Why charge a higher unit rate (R/kℓ) for higher levels of usage?

Equity – Those that use water for "luxury purposes" can afford to pay to cross-subsidise basic services to the poor.

Conservation – Higher charges gives an incentive for people not to wastewater.

Economy – Infrastructure has to be constructed to accommodate higher use. Capital expenditure for new infrastructure can be postponed if people conserve water or, alternatively, revenue from higher charges can be set aside to cover the cost of future capital expenditure.

Figure 3: Reasons for implementing Rising Block tariffs

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [ ] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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F04

KUNGWINI WEST LOCAL MUNICIPALITY

NON-REVENUE WATER IN AFFLUENT AREAS

Intervention Type	Improved metering and billing
Reason	High levels of Non-Revenue Water
Cost	R600 000.00

During a programme aimed at reducing Non-Revenue Water (NRW) in the Kungwini Local Municipality to the west of Pretoria, the affluent and newly established Silver Lakes Golf Course Development was identified as experiencing large discrepancies between the volume of water supplied and the volume of water metered and billed via individual connections to private households. This was indicative of a high level of NRW which required corrective action.

"If the reasons for reducing levels of NRW are so compelling, then why hasn't this widespread and generally well-understood challenge already been tackled and defeated?

The reason is that reducing NRW is not just a technical issue but also one that goes to the heart of the failings of public water utilities in developing countries."

- World Bank

A programme aimed at establishing the reason behind the experienced losses and identifying elements that were contributing to the high level of NRW within the ring-fenced estate development was embarked upon.

Description

Based on the initial findings relating to NRW for the Silver Lakes Development, it was decided that further assessment work was required involving the following activities:

- Visual inspection of each connection/meter,
- Limited replacement of meters if found to be broken,
- Removal of debris trapped in the meter mechanism if a water meter was found to be standing,
- Correction of meter installation if required, and
- Advanced leak detection (or sounding) of underground network pipes if suspected of leaking.

Findings

Overall the number of stands where corrective action was required to the water meter to enable accurate metering and meter reading was higher than expected or anticipated. This could largely explain the high NRW % recorded for the development.

The following table provides a summary of the findings of the detailed assessment of water meters for the Silver Lakes Estate:

Table 1: Detailed Assessment of Water Meters

Description	Identified
1) Meter Functioning	52%
2) Meter Leaking	3%
3) Meter Incorrectly Installed	5%
4) Meter Covered	27%
5) Meter Stuck	4%
6) Empty Stand	4%
7) Meter Broken/Destroyed	1%
8) No Access	1%
9) No meter/Illegal Connection	3%

Notable were that many meters were found to be covered with soil/ground, making it impossible to obtain actual meter readings. This meant that consumptions were being incorrectly assumed, mostly at a lower value than the actual consumption of water recorded by the meter for the metering period in question. The lack of accurate metering also meant that it was difficult to measure and quantify NRW properly.

Corrective actions

Typical examples of problems identified during the assessment phase with meters, meter boxes and connections are represented in the Figures below.

Figure 1: Leaking connection

After completion of the detailed assessment, the following corrective actions were taken:

- Approximately 60 new water meters were installed,
- All meter boxes throughout the estate were cleaned to enable the reading of meters on a monthly basis,
- Corrections required to the billing database were communicated to the income section of the municipality, and
- Monitoring and management measures were recommended to the municipality to ensure that similar conditions or situations are detected earlier in the future and managed accordingly.

Recommendations

Based on the completed assessment, the following conclusions and recommendations were recorded and communicated to the municipality:

- Meter Reading: Not all the water meters were being read monthly. Some meters had not been read for over a year but still had a meter reading attached to them on the billing system, captured manually based on the fictitious readings for the previous 3 months,
- Calculation of Interim Consumptions: No systematic way of calculating an interim consumption in the absence of a meter reading was implemented on the billing system. Additionally, the assigned system codes were not being utilized with excessive human intervention in the entire process,

Figure 2: Leaking meter

- Reading Type Codes: Although the system had various meter reading codes, these were not understood by staff and hence were not being utilized. This impacted mostly on the generation of exception reports required to ensure the proper maintenance and functioning of installed meters in the field,
- Training on the Billing System: Adequate training of meter reading staff in the use of the VENUS billing system had not been undertaken. A lack of training modules and Procedure Manuals also existed,
- Segregation of duties: The Meter Reading Clerk had been assigned almost all metering and billing responsibilities, including the supervision of all meter readers, capturing of readings onto the system, attending to queries/ enquiries by customers (Customer Care), etc. This resulted in very little accountability in the system with almost no way for other staff members to become aware of the actual status of meters, meter readings and billing problems, resulting in the status of the situation on the ground going undetected for lengthy period of time.

Lessons Learnt

Although high levels of NRW tend to be associated with low-income areas in South Africa, it is worth noting that even in affluent high-income areas where affordability is not a concern, metering, billing and revenue collection procedures should be well managed in order to properly manage and reduce NRW.

The following lessons can be learned from this case study:

- Even in high-income areas, there is a need to properly monitor and manage NRW and formulate appropriate interventions,
- Accurate metering, meter reading and billing procedures are critical to ensuring proper revenue collection in affluent areas,
- Water usage and consumption in affluent areas tends to be high, providing additional justification to properly manage delivery of water services to these types of development,
- The status of water meters in high-income areas should be monitored to ensure they are functioning accurately at all times, thereby optimising revenue potential and reducing NRW,
- There should be proper segregation of duties between the various departments within a municipality, which will in turn highlight process and system problems that require attention, and
- Staff should be properly trained in assigned tasks and provided with a suitable level of supervision.

Figure 3: Leaking municipal connection

Financial Benefit

Based on measured consumption for the corrected meters, the potential additional income to the municipality was calculated to be in the region of R684 000 per annum. Comparing this benefit to the R600 000 price tag of the intervention, it can be seen that the payback period for the intervention is less than 1 year.

Project Highlights:

- ☑ Verified Savings
- ☑ Behavioural Change
- ☑ Political Endorsement
- ☑ Capacity Built
- ☑ High Level Management
- ☑ Cost Effectiveness
- ☑ Replicability
- ☑ Scalability
- ☑ Employment Opportunity

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INSTITUTIONAL MEASURES

Municipalities exist as third tier government institutions with a specific mandate to deliver services to resident communities and end-users. They are usually large and complex organisations employing hundreds and even thousands of officials and workers. Often the volume of water used by the municipality itself can be considerable and usage by other government departments, institutions and entities such as the department of education, can be of equal or even greater proportion.

The complexity of the organisation and its bureaucratic processes can hinder and distract from service delivery and make managing water demand extremely difficult, given that WDM in itself can be a management intensive exercise requiring a high level of planning, structure, resource allocation, organisation, investment and intervention.

Institutional arrangements therefore in relation to WDM are important and case studies that highlight institutional planning for WDM, institutional water use, policy, alternative service delivery mechanisms and the adoption of austere water restrictions during a severe drought have been documented in the following section.

Documented case studies do not necessarily represent best practice or successful achievement of stated objectives. They do however represent experiences that could find broad application by other municipalities, but may require a different approach or a hybrid type of solution.

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EKURHULENI METROPOLITAN MUNICIPALITY
DEVELOPMENT OF A WATER DEMAND MANAGEMENT STRATEGY

Intervention Type	WC/WDM Strategy
Reason	Reduce demand for water
Cost	developed in-house by the metropolitan municipality

Ekurhuleni Metropolitan Municipality (EMM) is located in the East of Gauteng. EMM was formed through the amalgamation of various former East Rand towns including Alberton, Benoni, Boksburg, Brakpan, Edenvale/Lethabong, Germiston, Kempton Park/Tembisa, Nigel and Springs. EMM has a population of 2.7 million people, of which 653 000 have been classified as poor or indigent. EMM is the second largest bulk water consumer (after the City of Johannesburg) supplied by Rand Water utilising approximately 25% of the total volume of water supplied by Rand Water to the local authorities. In EMM's 2006/2007 Financial Year the total System Input Volume (SIV) averaged 26 million kℓ/month. It is estimated that approximately 55% of this water was unaccounted for, or classified as Non-Revenue Water (NRW).

> "The National Water Act (Act 36 of 1998) recognises that effective water resource management can only be achieved if all water resources are managed in a holistic manner."
>
> *-DWA*

As a water scarce country, South Africa experiences a little over half of the world's average rainfall. Continued increasing consumer demand is adding to the pressure already imposed on the country's scarce water resources.

Together with industry, Water Service Authorities (WSAs) have the largest expected future growth in demand which will require on-going development of bulk infrastructure and as yet undeveloped water resources. It is thus becoming more important to plan for and implement interventions that focus on water conservation whilst also taking into consideration the need to supply water to meet the demands of the urban population in a sustainable manner.

With this in mind, EMM identified the need to develop a Water Conservation and Water Demand Management (WC/WDM) strategy to assist with the implementation of projects, programmes, interventions and improvements aimed at conserving and better utilizing the existing resource.

Developing a WC/WDM Strategy

The purpose of a WC/WDM strategy at the municipal level is to improve the efficiency and effectiveness of both water service delivery and customer end-use, through the implementation of various technical, financial, institutional and behavioural interventions.

Water Demand Management interventions do not need to translate into reduced water use by end-users. Rather by focusing on known inefficiencies and wastage, the more effective use and delivery of water can be achieved without a corresponding reduction in volumes of Revenue Water delivered to customers. This also implies that efforts to reduce or better manage demand will lead to a more sustainable and affordable service delivery regimen.
Underpinning the development of a strategy should be the principles of Water Conservation (WC), Water Demand Management (WDM) and Integrated Resource Planning (IRP) which take into account the roles and responsibilities of the Water Service Institution, the Water Service Authority, the Water Service Provider as well as the end-user. A thorough

understanding of the workings of the distribution system, consumer water use patterns and behavioural issues is crucial to the development of an effective strategy.

WC can be described as the overall principle that requires the effective management and protection of water resources. WC should be considered as both an objective in water resource management as well as a strategy to be adopted by WSAs and WSPs when developing a WC/WDM strategy. A WC/WDM strategy should reflect the fact that South Africa is a water-scarce and water-stressed country.

There are two main processes to developing a strategy as outlined in the processes shown in Table 1. The first strategy is to establish a situational analysis, which is then followed by a comprehensive business plan. The situational analysis involves the determination of environmental factors that affect water resources by conducting a comprehensive data gathering exercise. Formulation of the business plan is then informed by the collected information which also presents objectives, steps to implementation, action plans and proposed interventions.

Objectives

EMM saw it as imperative to develop a strategy that would aid in the implementation of WDM projects and initiatives. The stated purpose of the WC/WDM strategy was to:

- Clearly illustrate the strategy EMM would follow towards addressing current water wastage and inefficient use,
- Provide a roadmap as to how EMM would capacitate and resource itself in order to successfully decrease water wastage and improve efficiency, and
- Document how EMM would sustain implemented interventions aimed at decreasing water wastage and improving efficiency.

Implementation

In 2007 after completing a DWA-funded pilot project involving implementation of various WC/WDM initiatives, EMM became aware of the need to prepare a comprehensive WC/WDM strategy. The strategy was developed using the WC/WDM National Strategy Framework published by DWA, as well as other resources available on the internet. Lessons learnt from the pilot project were incorporated into the strategy document.

In 2008, a draft document was distributed to stakeholders who were invited to participate in a review workshop aimed at soliciting comments from all role-players and interested parties. Along with the target of reducing total water purchases by at least 15% in five years as required by DWA, the proposed strategy also set targets to reduce water losses by 50%, improve payment for water services by 50% and improve managerial, operational and administrative processes in the delivery of water services. The strategy also outlined activities and functions EMM would need to undertake in order to meet their stated WC/WDM targets.

Table 1: WC/WDM strategy development steps

Step	Situational Analysis	Business Plans
1	Collect and collate all relevant data	Identify possible WC/ WDM measures, assess their impact, estimate the costs and review results using the IRP methodology
2	Prepare a mass balance water audit	Consult stakeholders to develop awareness around options, impacts and costs
3	Prepare an audit of the quality of service provided and of the performance of the various system components	Revise options according to feedback from Step 2 and prioritise measures
4	Develop future scenarios including demand projections, level of service targets	Determine scope of essential indirect measures
5	Combine Steps 2, 3 and 4 as the Situation Assessment	Complete the Business Plan which should include implementation, sustainability, infrastructure and institutional development plans

Results

The EMM WC/WDM strategy provided a list of potential initiatives and identified some of the key governance and regulatory issues that required consideration within the municipal service delivery environment. Challenges faced by the industry in South Africa were also highlighted.

The strategy has become the accepted vehicle for implementing WDM projects in EMM and has had the added benefit of identifying a significant number of projects which also required implementation. It has helped significantly in providing overall direction for the municipality in WDM.

Lessons Learnt

Important lessons were learnt through the development of a WC/WDM strategy and are summarized as follows:

- Drafting a WC/WDM strategy helps tremendously in giving direction and focus to the implementation of WC/WDM projects. This strategy ensures that a municipality takes into consideration social, environmental, technical, and economic risks and aspects when implementing relevant projects, programmes and initiatives.
- A WC/WDM strategy helps focus, target and coordinate efforts by a municipality in reducing water demand. In this way effort is focused around initiatives that achieve maximum results with the highest benefit-cost ratio.
- Engagement with key stakeholders is crucial to obtaining buy-in and participation not only around implementation, but also in terms of decision-making.
- Conducting of a situational analysis upfront of development of the strategy is instrumental in highlighting constraints, opportunities, strengths and weaknesses, which in turn ensures that the developed strategy can be successfully implemented.
- Formulation of a WC/WDM strategy should be done within a broader context of Integrated Water Resource Management (IWRM), which incorporates not only other users of surface water such as agriculture but also the Ecological Reserve in an overall Water Conservation and Demand strategy.

It is estimated that the potential economic benefit of WC/WDM over the next fifteen years to the Water Services Sector in South Africa will be approximately R50 billion.

Much of this could be achieved through cost savings in the postponement of capital infrastructure and savings in operating costs.

Project Highlights:

- [ ] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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OVERSTRAND LOCAL MUNICIPALITY
GREATER HERMANUS WATER CONSERVATION PROGRAMME

Intervention Type	Overarching programme
Reason	Water source capacity limited development
Cost	Unknown

The Khoisan are the earliest known habitants of the area where Hermanus Pieters followed an elephant trail, in the early 1800s, to a spring by the sea which became known as Hermanuspietersfontein. In 1904 the name was shortened to Hermanus when municipal status was given to the town. In 2000 Hermanus was included in the greater area, and is the main centre of the Overstrand Local Municipality, which also includes the towns Rooi Els, Pringle Bay, Betty's Bay, Kleinmond, Stanford, Gansbaai, Pearly Beach, Buffeljags Bay, Viljoenshof, and Baardskeerdersbos.

Hermanus is known as "The world's best land-based whale-watching site" and is internationally famous for cave diving, with Great White Sharks (Gansbaai). The future of the Overstrand's economy cannot be separated from the region's natural heritage and physical beauty, but its' biggest asset, its natural resource base, is limiting the potential economic growth of the area.

> "The programme has transformed water management in a manner unparalleled in urban areas in South Africa."
>
> *-Yasmina Shabodien*

Water Conservation and Demand Management

The population of Hermanus triples to 60 000 inhabitants during the holiday seasons and water consumption levels started exceeding the expected increased water supply levels. This suggested that there were high water losses and or wastage. Furthermore, these sharp summer peak demands were in an area that receives a winter rainfall. To make matters critical the water supply allocation from the De Bos Dam, at the time of construction in 1976, was expected to meet demands up until 2010. Due to the economic boom of the 1990s the water allocation from the De Bos Dam was exceeded in 1994/5 with only 70% of the potentially available properties developed. Hermanus, at the time, was allocated 2.8 million kℓ/annum from the De Bos dam but in 1995 was using 4.9 million kℓ/annum.

Figure 1: Greater hermanus water conservation programme

Water Supply augmentation schemes, such as increasing the size of the De Bos Dam (where analysis showed that the available yield from the resource did not increase significantly by increasing the size of the dam), groundwater abstraction (options were available but treatment and distribution costs to utilise this resource were inhibiting) and desalination (capital and energy costs were again too high) were considered but would not solve Hermanus' water shortage crisis. Hermanus, therefore, had two options:

- To put a moratorium on the development of new properties until additional water could be sourced, or
- To implement a Water Conservation/ Water Demand Management (WC/WDM) programme as a long-term investment.

In September 1996 Hermanus was the first town in South Africa to implement a holistic WC/WDM approach.

Objective

The aim of "The Greater Hermanus Water Conservation Programme" was to reduce water consumption by 30% over the next 3 years by implementing a 12-point WC/WDM plan. To fund the programme an additional 15% in revenue had to be sourced from the water sales.

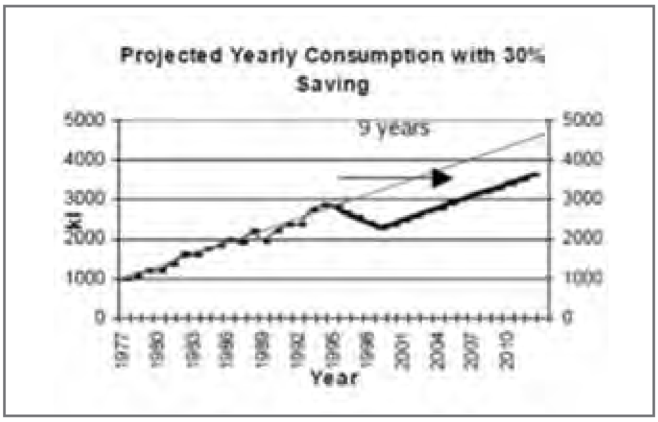

Figure 2: Hermanus water consumption

Description

Hermanus' water crises led to an unprecedented 12-point plan, namely "The Greater Hermanus Water Conservation Programme" which follows:

1. Assurance of supply tariff

This tariff is designed to cover the basic monthly cost of the "privilege" of having clean water delivered to a property or the cost of "assurance of supply". Hermanus is a typical holiday town with approximately 35% of the dwelling units unoccupied for most of the year. The Municipality needed a constant income to manage the water supply network throughout the year. This tariff was, therefore, not dependent on the amount of water sold but as a standard service charge included on the monthly water account. The tariff did, however, also make provision for the different economic groups.

2. Escalating block rate tariff

The objective of this tariff is to increase the cost of water as the household's water consumption increases. Wasteful or luxury water consumption therefore becomes more expensive. Further, lower income groups are also not cross subsidising and paying, as was previously the case when there was only one tariff which increased to cover the costs, for bigger costly augmentation was schemes that are needed to supply this additional water.

The tariff was designed with 11 steps or blocks, each block with a specifically allocated volume of water, and each successive block of water at a specific cost per kℓ. Each successive block of water was at a higher cost per kℓ.
As the consumer uses water the consumer will pay for the water used at a specified tariff per kℓ for the volume of water used within that block. After the allocated volume of water for that block is used, the tariff per kℓ is then increased as specified for the next block of water being used. The cost will only increase for the additional volume of water used.

In this way the tariff is structured so that, as a household uses more water, the cost of the additional water is higher per kl. Thus, the tariff structure is designed to cover the costs for infrastructure upgrades or for the augmentation of additional water because of an increase in demand for water by those consumers using this additional volume of water.

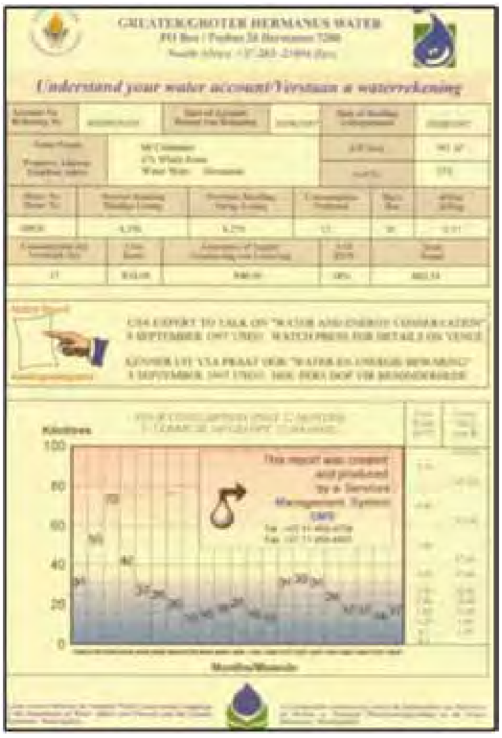

Figure 3: Hermanus water account

The choice or control of the cost of water with this tariff system lies with the consumer. The lower end of the tariff was also called the "life-line tariff" which was set for users in the lowest of the income brackets. Later it was "converted" across South Africa to "Free Basic Water" of 6 kℓ/month/household. This also became a strong mechanism or tool for the municipality (and later other municipalities) to address non-payment of water without infringing on a person's right to water.

The rising block tariff system was based upon an estimate of the reasonable water consumption per residential unit and defined as a "single residential unit". To accommodate the non-resident high consumers (e.g. industries, businesses, multiple unit buildings, retirement villages, schools, guest houses) into the tariff structure, residential unit equivalents (RUEs) were used to determine the monthly consumption of the non-residential consumer.

Figure 4: Example of a pamphlet in hermanus

The non-residential consumers were each allocated a number of RUEs. The number of RUEs were calculated by taking into consideration the "assurance of supply tariff" and the "block tariff" so that they too would be accountable for their water consumption. For example a guesthouse would be allocated three RUEs. This would mean they paid 3x the fixed cost, were allocated 3 x 6 kℓ = 18 kℓ per month free water and each tariff block volume was multiplied by 3.

3. Informative billing

As mentioned above (Escalating Block Rate Tariff) the consumer has the choice and control over the household's water consumption. To do this the consumer must have the necessary information. For this reason the informative billing system has had an overwhelming positive reception by the public. Water demand management was now "accessible" to everyone. The consumer clearly understood what the household's monthly water consumption pattern was. The graphic display of the monthly water consumption (showing the past 13 months) would have helped the consumer to "budget" for and to "manage" their water consumption. Figure 3 is an example of an informative bill issued by Hermanus.

4. Water wise gardening

Of the total water used by a household, 25% is for gardening purposes. Poor gardening practices and over irrigation has a major impact on the water consumption of a household. "Water-Wise Gardening" projects were implemented and demonstration gardens were set-up to encourage owners to plant indigenous plants and to plan gardens in a water-wise manner.

5. Water-wise food production

The potential use of "greywater" (water already used in the home, such as in baths and showers) to be used as irrigation water for certain food production was encouraged. Water used by communities, in the towns or close to the sea, when disposed of, is lost to the sea. By re-using the greywater, especially for gardens, this significantly reduces the demand for water from the municipality and the water resource.

6. Water loss management

Although the Non-Revenue water in Hermanus was only 18%, the Municipality set a target to bring this level down to 5%. The water losses were attributed to the following broad categories:

- Unmetered or illegal connections,
- Under-registering or inaccurate meters, and
- Leaks in the overall reticulation system.

7. National water regulations

The proposed new water regulations as published by the then Department of Water Affairs and Forestry were accepted in principle by Hermanus. The significance of these new regulations include, amongst others:

a. Audits by the municipality of its own performance in water management,
b. Ban on watering of gardens between 11h00 and 15h00 when more than 60% of water is lost to evaporation,
c. Ban on washing down paved surfaces with a hose pipe,

d. Guidelines on the energy and water-use design parameters for new houses and developments.

8. Retrofitting of water saving devices

The aim of the project was to retrofit all existing residential units in Hermanus (approximately 8 500 units) with approved water saving devices such as dual flush toilet mechanisms, low flow shower-heads, tap aerators and flow restrictors. 50% of the total demand for water in Hermanus came from within the home environment. The additional revenue that would be received from water sales due to the increased tariffs were to be used to fund this part of the project and at no cost to the consumers.

9. Security meter

Security/communication/pre-paid meters with panic buttons (for emergency services) were to be installed at 400 houses in a specific reservoir supply area in Hermanus as a pilot study to combat crime and non-payment. The meter empowers the consumer by providing relevant information as to how much water has been used and how much credit is still available to the consumer. The meter is also able to dispense different volumes of water at different costs including the 6 kℓ of free basic water.

Table 1: Comparison of Bulk Water Figures

Date	kℓ/day	ℓ/erf/day	Rainfall (mm)
1993/4	11 900	1 506	140
1994/5	12 075	1 473	120
1995/6	10 842	1 261	192
Average	11 606	1 410	151
1996/7	9 000	960	168
Savings	25.5%	31.9%	11.3%

10. Alien vegetation clearing

The clearing of alien vegetation in the catchment area of the De Bos Dam, also referred to as the "Working for water project", would ensure that the yield of the catchment area and the run-off into the dam is maximised. South Africa is faced with the invasion of alien vegetation which is reducing the flow of water to the watercourse (resources). The project success lies in the employment of people and the ecological winning back of land from these invasive alien vegetation species.

11. School water audits

The eight schools in the Hermanus area were actively engaged in raising the importance of the water conservation campaign and the auditing of water use at the schools. The project was aimed at influencing the young by teaching them good habits and using this as an "access" point into the homes of people living in Hermanus.

Communication

An intensive communication action was used to keep the consumer informed about the water conservation programme (See Figure 1 and Figure 4). This included press releases, talks with ratepayers and interested groups, displays, a monthly newsletter and a hot-line telephone facility. The reverse side of the informative billing was also used to communicate water saving tips to consumers.

Results

In the first four months, a 25 per cent saving was achieved (See Table 1) in the period November 1996 to February 1997. Only a few sections of the 12-point plan were implemented. Some of these initiatives still exist in the now Overstrand Local Municipality 12 years later, some of which would have had to have been reinstated. The back-bone of this WC/WDM programme still remains the increasing block tariff system – now used across the country.

Lessons Learnt

Perceptions of programmes, like the Hermanus WC/WDM programme and similar actions taken in the Knysna Local Municipality, is that once the "crisis" has been averted there is no longer a need to conserve water.

Of the 12-point programme not implemented, the retrofitting of water saving devices, the water loss management programme and the water-wise gardening project (by the local authority) were expected to reduce the level of consumption significantly, although it appears this was never tested.

The average growth rate in new housing units over the next three years was 9%/year, which could be attributed to the success of the WC/WDM programme, albeit that the now Overstrand Local Municipality is investing heavily in utilising the area's rich groundwater resources.

An intensive communication campaign was essential to ensure co-operation and participation from the community, and WC/WDM was taken into the homes of consumers. It is clear that WC/WDM must become a way of life, and not only during periods of drought.

Informative billing was one of the most powerful tools for consumers to manage their own water wastage.

Over-irrigation of the gardens was found to be the main cause of water wastage.

Similar Case Studies

Another municipality that has implemented a similar project more recently, but with it's focus mainly on communication, was the Knysna Local Municipality.

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [ ] Scalability
- [x] Employment Opportunity

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JOE GQABI LOCAL MUNICIPALITY
WATER DEMAND MANAGEMENT

Intervention Type	Institutional
Reason	Funds made available by DWA to initiate and implement WCDM projects and programmes
Cost	R1.5 million

Situated in the Eastern Cape the Joe Gqabi District Municipality (JGDM) comprises of the Senqu, Elundini, Gariep and Maletswai Local Municipalities with an estimated population of 355 000 people of which 320 000 are classified as indigent. JGDM abstracts and distributes 414 800 kℓ/month of water of which 60% is attributed to Non-Revenue Water.

The South African government has set a precedent requiring all municipalities to take active steps in reducing their water consumption by 15% to ensure a sustainable supply of water into the future.

With the large water losses occurring in the JGDM there was a need to implement interventions to curb high water wastage and inefficient water use. The Department of Water Affairs (DWA) in the Eastern Cape made R1.5 million available to implement a water conservation and water demand management (WC/WDM) programme in the JGDM.

> "South Africa's water resources will be fully utilised within the next 20 years."
>
> *– South African Government*

Water Demand Management

Water Demand Management is the development and implementation of measures aimed at influencing the demand for water by the consumers. The objective is to achieve a lower water consumption level that is reasonable and efficient. The rate of the demand for water in South Africa is increasing persistently because of improved provision of basic water and sanitation services to the previously underserviced communities and the continual growth in population.

Therefore WDM is important in that it presents an alternative solution to supply side augmentation. To augment a municipality's water supply is becoming more impracticable because it is either too expensive, new water resources are further away or deeper, water pollution is a problem increasing treatment costs and the high cost of complex technical solutions requires expensive specialist skills.

Figure 1: Illegal connection

WDM measures can be categorised into behavioural, institutional, socio-political, financial and technical and may include such interventions as water awareness campaigns, meter reading programmes, implementation of step tariffs and the removal of illegal connections. The categories are described as follows:

(1) Behavioural: interventions focus on influencing the end-user's attitude and behaviour in the direction of more efficient and sustainable water use practices.
(2) Institutional: interventions focus on strategies to improve the Water Services Institution's (WSI) ability to deliver water in an unbiased, efficient, sustainable and financially viable manner.
(3) Socio-Political: interventions are influenced by political concerns and usually involve interaction with the end-user.
(4) Financial interventions focus on monetary means to achieve the WDM objectives of a WSI.
(5) Technical: interventions include those measures that require a specific set of skills and technology in order to save water, such as the repairs to leaking household plumbing fixtures.

Objectives

The funds are made available by DWA to the JGDM for the establishment of a WC/WDM unit for institutional and social development (ISD unit), within the district municipal area which would thereby initiate and implement WC/WDM interventions

Description

The ISD unit initiated a number of interventions which aimed at addressing water losses in the area. Due to a lack of funds however, it became clear that there would need to be some interventions implemented other than that of conventional technical measures. One of these was a behavioural change initiative in the form of a water awareness programme which was initiated to inform community members about the importance of water and water conservation with four ISD officers being appointed to run with the programme in each of the local municipal areas. These areas included Senqu, Elundini and Gariep and Maletswai. The officers made presentations to all community members, and at institutions such as schools and churches, imparting information on the best practices in water use, the negative consequences of illegal connections and municipal by-laws.

An institutional programme, initiated by the ISD unit, was a meter reading training programme. This was aimed at improving the skills of meter readers as it was found that they were not performing according to the municipality's standards and they did not understand the importance of the work they were doing. This lack of skills and understanding led to a lack of correct billing of consumers, and accordingly decreased revenues to the municipality. JGDM realised that the role of the meter reader is crucial and that it extends beyond meter reading as the meter reader becomes an important point of contact between the municipality and the customer in relaying information on WC/WDM.

Another initiative of the ISD unit was to identify high water consumers. This process identified schools with high levels of water wastage. It was found that schools do not have a budget to fix leaks. So the municipality has engaged with schools to find ways of repairing the leaks.

Figure 2: Awareness campaign presentation

Technical projects initiated by the ISD included bulk meter reading in Burgersdorp, identification and removal of illegal connections and the "Find and Fix" project in which leaks were identified and fixed in indigent households across JGDM.

Results

The ISD unit has continued with its projects even after the direct support from DWA came to an end. This in itself is a significant achievement as many projects that have been initiated in the past by DWA have discontinued once DWA's funding and involvement came to an end.

The water awareness programme is showing great results in the changing of behaviour of the community members. Community members often notify the municipality of leaks and burst pipes which is of great assistance in the effort to conserve water.

Lessons Learnt

The success of the ISD in saving water can be attributed to:

- A strong leadership,
- Committed team members,
- Support from senior management that had not lost interest once DWA's involvement had ended,
- ISD officers appointed on a full time basis, and
- A water awareness message which appealed to the conscience of the community members, letting them know why it was important for themselves and their neighbours to conserve and use water wisely as their main focus. Despite a lack of funding, JGDM has showed that through leadership, a committed group effort, and internal institutional support, a successful WC/WDM programme can be initiated and sustained, showing results especially through the behavioural change in the communities.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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VARIOUS PUBLIC SCHOOLS THROUGHOUT SOUTH AFRICA

SCHOOL PLUMBING REPAIR, LEARNER EDUCATION AND CARETAKER TRAINING PROJECT

Intervention Type	Repairs and Retrofitting
Reason	High water losses
Cost	Undisclosed

The Coca-Cola Africa Foundation

This type of project is aimed at addressing schools in previously disadvantaged areas, characterised by poor facilities, non-payment for water, a lack of capacity to maintain facilities, water wastage and a general neglect of plumbing fixtures. The project was implemented only at identified schools located in different municipalities as a repair of school plumbing, learner education and the training of caretakers at schools. The Coca-Cola Africa Foundation, looking for opportunities to help develop communities through Water Conservation/Water Demand Management (WC/WDM) initiatives, in consultation with municipalities, identified schools with badly neglected plumbing fixtures as an opportunity to reduce Non-Revenue Water (NRW) at municipalities.

> "The reality today is that the issue of water is no longer limited to areas of the third world, but is predicted to soon be a major concern for people all over the world."
>
> *– Pure Inside Out*

Reasons for the Intervention

Big industries, such as breweries and paper manufacturers, are known to use large volumes of water, but schools and prisons are often the biggest users of water and unfortunately also some of the biggest payment defaulters. The situation is made worse with plumbing fixtures that are not properly maintained resulting in potable water flowing unused directly into the sewer system or just simply flooding parts of the school property. Municipalities ultimately carry the cost of this wasted water when schools do not pay for their water use.

Figure 1: before and after repairs

Poor water and sewage plumbing creates an unacceptable school environment and learners are inconvenienced. This sends the wrong message to learners and shows a lack of understanding for the proper use of water and the responsibility for water conservation to the future generations of South Africa

Objectives

- To enable and empower schools especially within disadvantaged communities to improve their water use efficiency and access to basic sanitation through education and awareness,
- Supporting key role-players including local, provincial

and national government, as well as community stakeholders in addressing the protection of water resources,

- Implementing water and energy efficiency intervention measures and supporting existing initiatives that ensure sustainable water use and the reduction of green-house gas emissions,
- Mobilising international awareness and support to address similar water issues, and
- Engaging the community to alleviate poverty through job creation.

Description

The overall approach and methodology of the project was to ensure that the work done at the schools would be sustainable.

Figure 2: If the budget allowed, then ablution facilities were painted including structural repairs

The project focused on all "components" of the school's plumbing, that is, repairs to the infrastructure itself, educating the users (learners) of the importance, use and care for the plumbing fixtures (this also had the spin-off effect that learners would transfer this information back to the adults at home), and the training of the caretakers at the schools to maintain the infrastructure. Training of caretakers included basic repairs such as the fixing of leaking taps and the importance of identifying and reporting the need for major repairs such as burst pipes. The caretakers were supplied with a small toolkit.

Figure 3: learners and educators participate

With the aid of the Department of Education and field visits, a number of schools were selected and visited. Selection was not only based on the school's state of plumbing fixtures, but on schools that showed a willingness to be involved in the project and, where possible, only schools showing the potential to maintain the repairs that would be done. Once a school was visited, a detailed assessment was drawn up including a bill of quantities which then determined how many schools could be addressed with the budget available.

The water supply to these schools was logged for 7 days to determine consumption, minimum night flows, consumption patterns, etc. The necessary repairs, education and training components of the project were then finalised. This was followed by a post-intervention logging to verify water savings achieved at the schools.

Each school's learners and educators participated in an hour-long presentation linked to the project (with a strong emphasis on water saving) where prizes (branded water bottles, stationery, etc.) were used to encourage participation. At the end of the presentation 3 learners were chosen as "Water Captains" to then monitor the school's consumption, report leaks, and relay the message from the presentation, etc. (see Figure 3).

Figure 4: The borehole supply is now used for drinking and the rainwater (harvesting tanks installed through project) is used for flushing the toilets. If there is a shortage of rainwater, then borehole water can be diverted to flush toilets

The school caretakers training included theoretical, practical demonstrations and on-the-job training:

- 550 000 kℓ water saved annually,
- R7.1 million saved annually on water and sanitation accounts which in most cases is a saving of NRW for the municipality,
- 3 826 people benefitted from project, and
- Rainwater Harvesting completed at one school and proven to work successfully.

Lessons Learnt

- In addition to the savings achieved at schools, the sanitation was improved immeasurably and therefore if this project was continued throughout South Africa the impact would benefit a large portion of the population through learners,
- The Department of Education, through the various municipalities, should roll this type of project out to all previously disadvantaged schools throughout South Africa as vast savings are experienced through straightforward interventions, and
- If a school has badly maintained plumbing fixtures then learners are forced to go home to use toilets and their learning is severely disrupted.

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [ ] Capacity Built
- [x] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY

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REPAIR AND RETROFITTING OF PLUMBING IN COUNCIL BUILDINGS

Intervention Type	Retrofitting of Plumbing in Council Hostels
Reason	high water losses at council hostels
Cost	R15 million

a world class African city

With funding secured from the national Department of Water Affairs, Johannesburg Water (JW) embarked on an intervention to reduce the amount of water supplied to Council-owned hostels, much of which was being wasted due to broken/vandalised or missing/stolen plumbing fixtures.

Motivation

Those responsible for the payment of a municipal account for water consumption in a government building – whether municipal, provincial or national – are often ignorant of potential water wastage, or the state of plumbing of the facility in question. This occurs because the payment of accounts is normally a centralised function within government and the Accounts official is geographically or institutionally disconnected from the facility, the maintenance and the management thereof. Similarly the caretaker of the building never sees the municipal account and cannot link actual water wastage to the cost associated with same.

The net result is that the cost of water wastage and/or inefficient use most often goes unmanaged or unnoticed. This is especially true of public facilities such as schools, hospitals and in the case of Johannesburg, municipal hostels owned by Johannesburg. Budgets are often depleted on water bills alone with little or no funding remaining of maintenance and repairs and no one taking responsibility for maintenance of plumbing.

Recognition of Problem

Various studies have identified opportunities to reduce water losses in government buildings, schools and hostels. Investigations undertaken by the City of Johannesburg's (CoJ) Department of Housing indicated that internal plumbing in most municipal hostels is in an extremely poor condition. Maintenance of plumbing is almost non-existent with many fittings having been vandalised or stolen, leading to water waste on a grand scale. Johannesburg Water identified four Council-owned hostels with high water consumption and also no payment for water. The utility initiated a project to repair/replace and retrofit plumbing at these hostels. It was envisaged that by retrofitting especially plumbing fixtures in the hostels, water losses could be reduced considerably.

Figure 1: Stagnant water outside hostel due to water leaks

The original scope of the project also included refurbishing water supply infrastructure which was in many cases dilapidated/irreparable and contributed to water losses. Initial assessments established that much of this infrastructure had collapsed completely.

In addition to the water wastage, blockages in the drainage system were causing sewage to overflow on the surface, increasing the chances of a disease breakout amongst the hostel dwellers.

Objectives

Johannesburg Water set as a target for this intervention the reduction of water consumption by at least 20% at the beneficiary hostels.

The aim of the project was to repair and retrofit plumbing fixtures in four government/council owned hostels, three in Alexandra (namely Helen Joseph, Nobuhle and Madala) and one in Dube, Soweto. Fixtures that were identified for replacement included kitchen sinks, toilets/water closets, hand basins, laundry tubs and underground pipes in and around the hostels. Other potential spin-offs from the project included improving the living conditions of hostel communities through improved sanitation and hygiene, lowering of outbreaks of water-borne diseases such as cholera and stomach infections, lowering of bad odours, as well as lowering the presence of insects such as mosquitoes, flies and cockroaches.

Figure 2: Madala Hostel effluent flowing directly on to property

Implementation

Hostels were selected for implementation of the project based on verified water losses and wastage. An on-site investigation of short-listed hostels revealed that infrastructure in and around the hostels was old and/or severely damaged and that wastewater infrastructure would also need to be refurbished in order to improve the general condition of the hostels. The lack of maintenance over many years was also apparent.

It was anticipated that through the replacement of fixtures and fittings the water losses within the hostel perimeter could be reduced.

Repairs vs. Retrofitting

An approach of either repairing or retrofitting plumbing fixtures can be adopted when addressing water losses taking place on properties (or beyond the meter).

Repairing generally entails fixing and bringing back to working order existing fittings. An example could be a leaking pipe or broken tap that is repaired to original working condition.

Retrofitting constitutes the modification, adaption or replacement of inefficient plumbing fixtures known to use high volumes of water with more modern efficient fixtures that generally use less water to achieve the same result. Examples of retrofitting include replacing old shower heads with low flow aerated shower heads, replacing tip-tray urinals with manual flush button systems or even waterless urinals, and standard pillar tapes with push-button taps.

Results

No meter readings were taken before the implementation of the intervention thus JW could not properly assess the impact the retrofitting had on water consumption. However from physical inspection, it could be seen that there was an improvement and water was being saved (see Figures 3 to 6). An example is that prior to implementation, water leaks had led to flooding in bathrooms making it difficult for individuals to enter, however post retrofitting this had ceased thus implying that water had been saved .

Figure 3: (Before) Leaking automatic flushing urinal

Figure 4: (After) Retrofitted manual flushing urinals

Figure 5: (Before) Missing basins in hostel due to vandalism and theft

Despite this achievement meter readings post intervention show that water consumption has been rising steadily by between 10-15% for all the hostels. JW is still to determine what the cause is, but it is reasoned that it could be either due to an increase in occupation leading to escalated demand, wastage occurring due to inefficient water use or leaking plumbing fixtures as a result of vandalism or theft.

Figure 6: Basins with water efficient faucet installed

Challenges

JW has experienced a number of challenges during intervention implementation which has included resistance by hostel dwellers. Although physical inspection shows that water savings have accrued, the question is raised whether savings can be sustained over the long term at hostels given the adverse culture towards maintaining the living space in good condition. It has been identified that the lack of education and knowledge surrounding the intervention has played an important role in how hostel dwellers perceived the intervention and its impact on their lives.

One of the challenges affecting the success of the project has been the theft and vandalism of fittings after retrofitting which has led to water wastage. Although an awareness campaign was undertaken, bestowing a sense of ownership by residents was difficult, especially given that there is a high turnover of occupants. New occupants generally tend to display a poor attitude towards water efficiency practices. Security on site was also a major issue during implementation with armed robberies and the hijacking of a vehicle reported by the contractor. Contractors on occasion had no access to work areas due to residents refusing to vacate these areas. It was reported that community leaders were trying to interfere with the labour recruitment process. Access to working areas, in some instances, was also blocked due to overflowing human waste. Working conditions had to be improved to meet safety standards before the retrofitting work could commence.

Along with poor weather conditions which delayed the relaying of pipelines to hostels, a labour dispute forced further delays. Workers were demanding wages higher than what was previously agreed upon in the contract. A series of meetings facilitated by the City's Housing department had to be held with the community to resolve this dispute.

Lessons Learnt

- No meter readings were taken before the implementation of the intervention. Therefore JW could not assess quantitatively the impact the retrofitting had on water consumption post intervention. It is therefore important to collect consumption data prior to implementation to derive saving levels post implementation and assess whether the intervention was a success,
- Given that data is showing that consumption at hostels is increasing, JW cannot link this increase to either water wastage through inefficient water use or increased

consumption due to an increase in population. Thus JW found that it would be advantageous to collect data on the changing population numbers over a period of time so as to determine the source of the increase in consumption,

- As compared to the Helen Joseph Hostel where few problems have been experienced with vandalism and theft, the residents of the Madala Hostel vandalised retrofitted plumbing fixtures after they had been installed. This behaviour has been linked to a lack of knowledge on the purpose of the intervention and how it affects its targeted recipients. JW stated that it was thus important to convey a strong message on the importance of conserving water and maintaining plumbing fixtures in good working condition. The lesson learnt was that for this intervention to succeed community buy-in would be of the utmost importance,
- With the view of reducing high water wastage in institutions, implementing a leak repair programme is seen as being a beneficial intervention in achieving water conservation and demand objectives. However, given the challenges that have been faced by the contractors and JW, it has been concluded that this type of intervention is better implemented in an institution like a school in which there is a basis for the creation of sustainable savings, rather than hostels in which no ownership of property exists. Residents do not pay for water and there is a large turnover in occupation making it difficult to retain water conservation and use efficiency knowledge,
- A strategy of creating a forum and appointing individuals from the hostel to monitor and enforce recommendations of the forum seems to have had a greater impact in reducing theft and vandalism.

Project Highlights:

- [ ] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [ ] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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eTHEKWINI METROPOLITAN MUNICIPALITY

106 COMMUNITY ABLUTION BLOCKS

Intervention Type	Community Water and Sanitation Services for Informal Settlements
Reason	Lack of water and sanitation services
Cost	R400 million

There are more than 400 informal settlements scattered across the eThekwini municipal area. Communities in these informal settlements represent the urban poor who live in basic shacks and suffer from poor water and sanitation conditions.

By installing community ablution blocks, the municipality is able to provide shared water and sanitation facilities to these communities at a ratio of approximately 100 dwellings per ablution block.

From the perspective of the Municipality, it is important that these services are provided in a sustainable and manageable manner and that potential water wastage is minimised.

Reasons

The constitution requires that municipalities take responsibility for providing basic water and sanitation services to the people within its jurisdiction. The Department of Water Affairs requires that services must be provided according to the principles of, amongst others, environmental effectiveness and sustainability.

> "We think of our land and water and human resources not as static and sterile possessions but as life-giving assets to be directed by wise provisions for future days."
>
> *-Franklin D. Roosevelt*

As part of this mandate, the eThekwini Municipality embarked on a project that sought to provide temporary water and sanitation facilities to informal urban and peri-urban settlements.

Objective

The main objective of the intervention was to provide a sustainable water and sanitation service to informal communities.

Description

Ablution blocks constructed were connected directly to the municipal water and sewer networks. In areas where no waterborne sewerage exists, storage tanks are used and the effluent is removed at regular intervals by the municipality. For management purposes the ablution blocks are metered as separate units. In this way the water consumption including the identification of leaks or water wastage can quickly be determined and resolved. To further restrict pipe or plumbing fixture bursts due to high system pressures, water supply to the block is pressure managed.

Illegal connections are managed, not by removing them or installing flow restrictors, but by formalising these connections through the installation of water meters and reducing wastage through repairs.

The Municipality has also hired caretakers at each block who manage and clean the facility, ensure availability of toilet paper, report to eThekwini Water about structural problems including leakages and pipe breakdowns, and ensure that residents have access to the facility. Caretaker training is conducted by eThekwini Water and Sanitation (EWS) staff and addresses technical, environmental, hygiene and management aspects related to the ablution block.
Community education and training has been an integral part of the project and focuses on promoting water conservation, water demand management, sanitation, health and hygiene awareness. Educational mediums include posters and leaflets which are provided in both English and isiZulu. Street theatre performances are also conducted in an effort to reach the poorest and illiterate community members.

In conjunction with the theatre performance there is a competition which attempts to enhance community participation through a lucky draw and the awarding of prizes.

Achievements

In 2010, the total number of Ablution blocks installed amounted to 348, with EWS having installed 240 blocks since they took over the project from the provincial department. An estimated 120 000 families benefit from the project by having access to safe hygienic sanitation facilities.

The net result is an increase in the quality of life and dignity of these people, and the reduction of the possible spread of diseases amongst poorer communities.

The community ablution block concept implemented in conjunction with properly trained caretakers who are supported by the municipality helps in managing overall water demand and avoids many of the problems associated with open-ended water supply to individual shacks and informal dwellings. This is especially so in terms of water wastage. It is therefore an effective water demand management approach to servicing these types of communities.

This approach has also provided employment opportunities for caretakers who were selected from the beneficiary community. During the construction phase, capacity building in the form of a mentorship programme for local contractors was also provided by the firm contracted to build the ablution blocks.

Lessons Learnt

The success of this type of approach is largely dependent upon successful community consultation. "Community involvement and buy-in are a key component to ensuring the success of this project," says eThekwini Project Executive, Alan Kee.
An additional potential benefit of this approach could be the implementation of water and wastewater re-use interventions at each ablution block. Studies have shown that re-use of wastewater can be employed in both agriculture and the recharging of ground water.

Reusing wastewater has an economic benefit when compared to the costs of operating and maintaining a centralised conventional treatment system. Installing conventional treatment systems in remote areas or in areas where no such systems exist has the disadvantage of requiring a large capital outlay.

With this in mind, the Municipality has been conducting extensive research into various re-use options which could further benefit the sustainability of the project, one of which is the Decentralised Wastewater Treatment Systems (DEWATS). A case study on the DEWATS concept is included in this compendium.

Further lessons learnt are captured in Table 1 below:

Table 1: Lessons learnt from past experience and related interventions.

Past Experience	Interventions Made
Major maintenance problems have been identified in areas where there was no caretaker supervision	Local caretakers are appointed and paid a regular salary by eThekwini municipality
Users did not purchase toilet paper and made use of newspapers causing blockages of the systems	Toilet paper and washing material are provided by the Municipality and freely distributed by caretaker
In some areas crime and anti-social behaviours occur at night, making it difficult for women and children to use the facilities	The provision of lights and fences, as well as constant presence of a caretaker provides a safer environment
Copper pipes and other material used for taps and showers had been stolen	Materials have been replaced by plastic pipes and taps

Project Highlights:

- [ ] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [ ] Scalability
- [x] Employment Opportunity

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eTHEKWINI METROPOLITAN MUNICIPALITY

LEVELS OF SERVICE POLICY

Intervention Type	Service Delivery
Reason	Formalise services
Cost	Developed in-house

eThekwini Metropolitan Municipality (EMM) is situated in KwaZulu-Natal with a population of 3.5 million people residing in both urban and rural communities. About 43% of the population earn below R1 500 per month. Approximately 27.3 million kℓ of water is supplied per month to all residents, of which 35% is considered to be Non-Revenue Water (NRW) made up of both physical (or real) and apparent (or commercial) losses.

The municipality services in excess of 1 million households, with the largest majority having access to running water within the vicinity of their properties. However, 36 000 households have to travel varying distances to collect water. Given the government's policy to provide all people with access to an appropriate, acceptable, safe and affordable basic water supply service in an equitable, affordable, effective, efficient and sustainable manner, the municipality has developed a policy relating to levels of water and sanitation service provided to domestic customers and how these will be delivered.

This policy also ensures that the public expectation of service delivery is matched by achievable and measurable performance standards and helps residential users effectively manage their available water supply.

> "Water is life's mater and matrix, mother and medium. There is no life without water."
>
> *- Albert Szent-Gyorgyi*

Service Level Standards

A service level standards policy can be defined as an agreement on the performance that service providers commit to deliver to customers. Service level standards convey understanding about what the customer can expect concerning services, priorities, responsibilities and warranties. By informing customers and creating some understanding, the expectations of the customer can be better managed, resulting in greater customer satisfaction at the end of the day.

Service level standards are used for:

- Setting expectations with external and internal customers and colleagues,
- Focusing service providers on the needs of the customer,
- Ensuring consistency of service,
- Providing a standard against which performance can be measured, and
- Encouraging service improvements.

A service level standards policy is also a Water Conservation and Water Demand Management tool in that the volume of water provided to customers can be better managed and contained. This is true of the eThekwini policy which also specifies that:

- All standpipes must be metered,
- Full pressure supply systems must have a water management device installed, and
- Tariffs are to be charged on all metered connections for consumption over a Free Basic Water volume of 6 kℓ per property per month.

Objectives

A Level of Service policy seeks to enhance the relationship between the Water Service Provider (WSP), in this case eThekwini Water and Sanitation unit (EWS), and the customer.

Additional objectives of such a policy could also include:

- Reducing areas of customer dissatisfaction,
- Clearly communicating the processes involved in dispute resolution,
- Eliminating unrealistic expectations,
- Clearly communicating escalation procedures in the event of differences arising between the service provider and customers, and
- Creating public awareness of how to get in contact with local WSP.

Description of Policy

eThekwini municipality provides its domestic consumers with three levels of services in order to provide water equitably and at an affordable cost. These levels of service are as follows:

1. Domestic Full Pressure Supply: A full pressured metered water supply is fed directly to the household from the City's supply network. This service is available in the formal housing areas throughout the Municipal area. Application for a connection can be made by calling at any of the Municipal Walk-In Centres. A connection fee is charged in terms of the applicable tariff for the size of connection (normally 20-millimetre pipe diameter) requested. Water consumption is metered and monthly charges are made in terms of the applicable water tariffs for domestic customers.

2. Domestic Roof Tank – Semi-pressure System: A semi-pressured supply is supplied to the household via a roof tank. This service is available in low-cost housing settlements. A "connection charge" is made for the semi-pressure water connection and the installation of the tank.

3. Stand Pipe with Water Management Device (previously the "Ground Tank – Low Pressure Supply"): The previously implemented Ground Tank Level of Supply has been superseded by a standpipe, water meter and a water management device that dispenses a maximum of 300 ℓ/day to the dwelling. This service is available in informal and rural settlements where potable water is also available nearby – normally a standpipe in the road reserve located within 200 metres of any dwelling.

Figure 1: Ground tank representing a basic level of service Water consumption is levied in terms of the applicable water tariffs.

National regulations recommend that municipalities provide households with Free Basic Water (FBW) of at least 6 kℓ per month free of charge. For those households which have a full pressured supply, consumption over and above 6 kℓ is then charged using rising block tariffs, while water supplied via standpipes is provided free of charge.

Notwithstanding the above, informal settlements are provided with standpipes as a temporary measure and for prolonged service interruptions, water sachets or water supplied via a tanker service is provided. The full pressured service is available to industrial, commercial, business and institutional customers.

Lessons Learnt

Important lessons that were learnt by the municipality in the implementation of a service level policy include:

- First establishing the needs of consumers by conducting consumer research,
- Being specific and measurable when drafting the service policy,
- Ensuring customers understand and agree with standards by rolling out an extensive awareness campaign,

- Ensuring that those people who are instrumental in delivering services recognise what is important to customers, and
- Matching the level of water service with equivalent sewerage service, so as not to cause public health problems.

Additionally stakeholder participation in the drafting and implementation of service level standards is important in gaining co-operation which ultimately helps in managing water demand.

eThekwini municipality has, by offering the differing levels of service, been able to meet the varying needs of domestic customers and in so doing has also been able to better control the level of Non-Revenue Water and water wastage.

Project Highlights:

- [ ] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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CITY OF TSHWANE METROPOLITAN MUNICIPALITY

PARKS METERING INVESTIGATION

Intervention Type	Metering
Reason	Ensuring that all municipal parks are properly metered and monitored
Cost	Unknown

The City of Tshwane Metropolitan Municipality (CTMM) has a population of 2.4 million people. There are approximately 350 000 households, of which 146 000 are informal, and a further 34 000 households are indigent. The municipality supplies approximately 23 million kℓ/month of water to the residents of the CTMM. It is estimated that 30% of the water purchased by the CTMM is Non-Revenue Water (NRW).

Water conservation in South Africa is becoming an important issue as studies are showing that current water demand trends cannot be sustained given limited available water resources. It has become important for water services institutions to put in place measures to reduce and manage water demand and NRW.

> "Increasing demand for water, and decreasing water quality, make careful water management a priority in our country."
>
> *-Delta enviro.org*

In order to manage and monitor water supplied, it is essential for municipalities to accurately meter all water connections including water supplied to municipal buildings and city parks as these sites can be sources of water losses if unchecked. CTMM initiated a meter audit of all irrigated road islands and parks throughout the city by establishing and correcting metering and billing inconsistencies.

Since water meters serving these types of properties are often located in positions that are not easily found by the city's water meter readers. An investigation was firstly initiated to find, audit and verify the status of meters, wether there was a meter, at all of the road islands and parks that are irrigated by the city. Secondly to verify if the water used is accounted for and billed correctly by the city.

Figure 1: Broken meter

The ultimate goal of the exercise was to reduce the NRW of the city by understanding how much water was being used in the city for irrigation of parks and road islands.

Non-Revenue Water (NRW)

NRW is water that has been abstracted by the municipality, or supplied by a third party to the municipality, treated for domestic use, distributed but lost before it reaches the targeted end-user.

These losses may be caused by leaking and burst pipes, illegal connections and metering inaccuracies. NRW is defined as:

- Unbilled authorised consumption which is the volume of water consumed not billed or paid for,

- Apparent losses which includes all water consumed illegally and revenue which is lost due to technical and administrative inaccuracies such as faulty meters or inaccurate meter readings, and
- Real losses include losses such as leaks and burst pipes occurring on the water distribution system between the water service provider and the end-user.

Metering

South Africa's limited access to available water resources requires that water is effectively accounted for and metering is an important tool in managing a water supply system. Metering enables the water manager to monitor bulk water purchases, water supplied through the distribution system, water consumed and water lost. The aim of metering is to identify, quantify and rectify causes of water losses occurring in the distribution system in an effort to minimise these losses, manage demand, and reduce the NRW.

Water utilities must also ensure they monitor their own water consumption, as part of balancing water purchased and water used is the implementation of measures in areas where their demand does not comply with their policy and they fall short of meeting their water conservation and demand management targets.

Figure 2: Unmetered connection

One area of focus should be the city's parks and road islands as they play an important role in both the city's living conditions and the city's development. These parks and islands however need to be maintained which includes watering amongst other maintenance activities. Thus creating the need to manage and monitor water consumption on the properties.

Table 1: Summary of Outcomes of the Meter Audit

Depot Names	No. of connections audited	Un-metered connections	Replace meter
Pretorius Park, Silverton, Morêgloed	84	2	30
Die Grasdak: Centurion Princess Park,	25	1	3
Kwagga Road, Mayville, Loftus	93	0	23
Klerksoord and Akasia, Soshanguve	57	1	6
Mayville	34	2	4
Total	**293**	**6**	**66**

Objectives

The overall objective of the project was to improve metering at the road islands and in the parks reducing NRW. Other sub-objectives included:

- Identification of unmetered connections,
- Identification of faults, including meters not working, old meters that were deemed inaccurate, meters that could not be read and meters which had a leak at or near the meter,
- Verification of meter installations to ensure they conform with the municipality's specifications,
- Identification of meters which appeared on site but not on the billing system, and
- The correction of any metering or billing inconsistencies.

Figure 3: Leaks observed at meter

Description

An audit was conducted at all irrigated road islands and parks to establish a list of all parks' connections throughout the city. This was followed by a process which involved the shutting-down of these connections in order to determine which of the connections were metered and which were not.

Where necessary, recommendations were made, based on the audit and a shut-down process to implement the necessary modifications to the connections.

Achievements

The meter audits have been completed and the subsequent meter replacements/installations are currently being undertaken (March 2011). Once the meter replacements/installations are complete, the impact of the exercise will be determined. A summary of the outcomes of the meter audits are shown in Table 1.

Lessons Learnt

- Meter auditing is a useful tool that can be used to detect metering inconsistencies which will assist in improving accurate meter readings and reducing NRW for any municipality,
- Understanding the municipality's water usage and losses on council owned properties is important in terms of aligning the municipality with their strategic objectives and thus setting a precedent for their consumers to follow,
- Accounting for all water used within a municipal boundary, including water used by the institution is an important activity to undertake on a regular basis,
- It is crucial to ensure that all metering inconsistencies, (including meters not working, meters showing incorrect reading, or where there is not a meter) that the faulty or non-existent meter identified in the audit process is replaced or that a meter be installed, and
- The impact of every meter audit and subsequent meter replacements should be determined to assess the benefit for the municipality.

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [x] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY

CORPORATISATION OF WATER AND SANITATION SERVICES

Intervention Type	Institutional arrangement
Reason	Improve operational and management efficiency

Located in the heart of the industrialised Gauteng Province is the City of Johannesburg, which is home to 4.0 million people. A quarter of these residents can be classified as urban poor who reside in informal settlements, backyard shacks or abandoned inner city buildings. Water and sanitation services are provided by Johannesburg Water (Pty) Ltd (JW), which was established as a Municipal Owned Entity (MOE) in 2001 as part of the greater iGoli 2002 plan implemented by the City of Johannesburg as a major transformation initiative aimed at creating sustainable service delivery entities

"Across the world, 884 million people do not have access to clean water and 2.6 billion do not have access to adequate sanitation."

– One International

Background

In the post-apartheid era in South Africa, local government has undergone enormous transformation, radically impacting on the delivery of water and sanitation services. The need to extend and enhance service delivery has had to be balanced with the need to create efficiencies and ensure technical and financial sustainability of services provided to existing customers.

The challenges faced during this period have demanded new ways of thinking, organising, operating, financing and delivering services, resulting in some municipalities giving earnest consideration to alternative service delivery models including Public Private Partnerships (PPPs), long-term concessions, the privatisation of some operations, creation of business units, as well as the corporatisation of trading services and/or the formation of appropriate utilities. This was especially true for the metropolitan municipalities including the City of Johannesburg (CoJ).

Institutional Transformation

As part of a major institutional restructuring exercise undertaken during the late 1990s, CoJ implemented a strategy known as iGoli 2002, which was aimed at addressing five key issues faced by the city namely, Financial Sustainability, Service Delivery, a Framework of Accountability, Administrative Efficiency and Political Leadership.

This strategy included the formation of Utilities, Agencies, and Corporatised Enterprises (commonly referred to as UACs or more recently as Municipal Owned Entities or MOEs), including Johannesburg Water (Pty) Ltd, representing a corporatised entity (or utility) assigned with the responsibility of providing and extending water and sanitation services to all the residents of Johannesburg.

Although various models were considered, a corporatised model – as opposed to a privatised model – was selected for a number of reasons, including an expectation that efficiency gains comparable to those attained by a privatised company delivering similar services could be achieved. Additionally the corporatised model would allow greater government involvement and in so doing mitigate negative social risks and perceptions associated with the privatisation of water services. Johannesburg Water (JW) officially came into being in January 2001 via the registration of the company, the appointment of a Board of Directors, the physical transfer of all water and sanitation assets from the municipality to the utility, and the migration of over 2 500 employees to the new entity.

From the outset, the city wished to inculcate international best practice into the management of the utility and in tandem with the formation of the utility issued a tender for suitably qualified Service Providers to provide management services to the utility. After a competitive adjudication process, a joint venture company, namely the Johannesburg Water Management Company (JOWAM) consisting of international and national partners was awarded a contract to manage the utility and progressively transfer skills, capacity and responsibilities to the newly established entity over the 5-year contract period.

As such, Johannesburg was the first and only local government in the post-apartheid era to follow a corporatised approach to water and sanitation service delivery as part of its greater transformation and sustainability plan. To date, the city remains the sole shareholder (or owner) of JW, while delegating its shareholder responsibilities as the Water Service Authority for Johannesburg to a Board of Directors appointed by city management.

The iGoli 2002 plan also provided for the establishment of a small Contract Management Unit (CMU) within the city's organizational structure to oversee the activities and operation of the 14 UACs, as well as ensure compliance with local and national legislation, especially in terms of service delivery standards. The city also established a Shareholder Unit (SHU) to ensure good corporate governance and financial viability of each of the UACs.

As was to be expected, various tensions have existed between the UACs, the SHU and the CMU – especially around independence of the UACs, authority of the CMU, allocation of funding, approval of CAPEX and OPEX, as well as regulatory responsibilities with regard to the setting of tariffs.

Much has been written and said, both for and against, the corporatisation of JW. It is not the purpose of this document to present political, legal or other such arguments for or against the establishment of said utility. Rather, this case study highlights how the corporatised model has facilitated a reduction in Non-Revenue Water (NRW), aided in managing and reducing overall water demand, and then describes some of the constraints of the chosen model that have prevented JW from making further gains in NRW, WDM and service delivery extension. Lessons learnt are summarised at the end of this study.

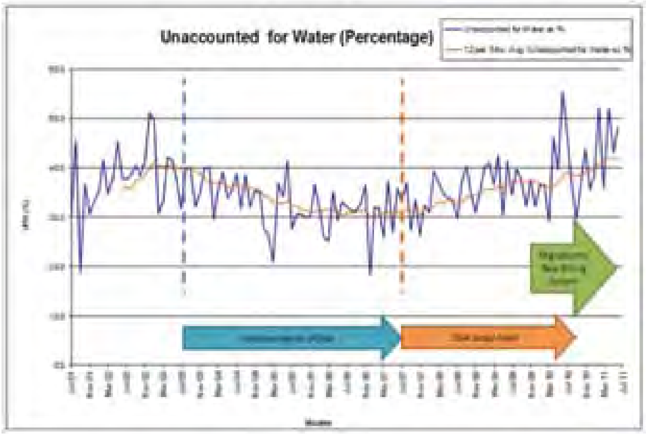

Figure 1: Water supplied by Johannesburg (graph supplied JW)

Objectives

In the case of a service orientated company, the aim of corporatisation would be to increase organisational flexibility and financial viability for delivery of a specific service by legally separating it from other functions performed by the various tiers of government. Variations of the corporatised model, such as a ring-fenced business unit within a government department, a crown corporation, or a fully corporatised utility are also possible.

What these variations have in common though, is a particular approach to accountability: the government becomes the single client for a publicly owned, yet institutionally separate service provider.

From the outset, JW was established to "run like a business" with its own board of directors, management and organizational structure and decision-making capabilities. As the sole shareholder, the city appoints the board of directors and the Managing Director of the company. Whilst the board is ultimately responsible for overseeing the operations of its company/ies to ensure commercial viability, it must also ensure that each company adheres to city policies, plans, strategies, objectives, by-laws and directives.

Discussion

Once established, the single biggest challenge faced by JW was the high NRW rate – estimated to be 43% in 2001. The

high NRW volume was apportioned to both commercial (or apparent) and technical (or real/physical) losses.
Physical losses were estimated to represent 10% of the System Input Volume (or about a quarter of NRW by volume) at the time. Physical losses relate to the age and condition of water supply infrastructure, up to and including the customer meter. The remaining losses were then attributed to commercial losses or losses relating to metering (or the lack thereof) and billing.

Reasons for the high commercial losses were given as:

- The unwillingness of the city to relinquish control of revenue functions for 40% of metered customers to JW. Although JW had the ability to manage metering and billing tasks, it was not delegated this task and/or authority by the city. However, over time, the city transferred total management of about 60% of the metered customer base to JW as well as all meter reading and credit control functions for the remaining customers, and
- The 'deemed consumption' (or flat rate) billing policy in areas with no meters such as Soweto, Ivory Park, Orange Farm and Alexandra. Through analysis of bulk meter readings, it was shown that the NRW rate was as high as 70% in the area of Soweto. In response, JW implemented Operation Gcin' Amanzi (OGA), a multi-pronged large-scale project that included repair of plumbing fixtures on private properties, installing prepayment water meters and rehabilitating/replacing the water network where necessary.

Results

As a result of transferring metering and billing functions for 60% of the customer base to JW as well as the implementation of OGA, JW was successful in reducing NRW to around 30% by 2007, as indicated in the graph below (Figure 1) Unaccounted for Water (UAW which is roughly equivalent to NRW) for the city. Although the overall NRW rate was still high, JW was confident that the rate could have been further reduced to around 25% by continuing with the implementation of targeted initiatives.

By 2007 the saving achieved was significant and represented a reduction in water purchases of 30 000 000 kl per annum. Taking only the purchase price of water from Rand Water in July 2007 into account (R3.07 per kℓ, excluding VAT), this represented a financial saving of R92m per annum to the utility at that time.

Since 2007, the NRW rate has been steadily increasing, mainly attributable to suspension of OGA, which was pending the outcome of legal action brought against the city and JW. In late 2009, as part of Operation Phakama, the city took back the billing function from JW, as part of an initiative to centralize billing and revenue collection functions under the Customer Relations Management Department within the city. The meter reading function was retained by JW.

The combination of these two factors over time and resulting loss of control experienced by JW have led to the NRW percentage increasing to 47.6% as of May 2011, shown on the graph above. Additionally, the physical losses have been steadily increasing as the water networks deteriorate over time due to a lack of investment in replacement/upgrading of infrastructure.

Challenges

As expressed by both JW and the CMU, the single most difficult and frustrating challenge that has arisen from the corporatisation of JW relates to ownership of the billing function and the lack of autonomy afforded to JW in being able to manage this critical function.

When the city initially endorsed the creation of a separate water and sanitation utility in 1999, the intention was that the utility would operate independently and take control of all metering and revenue collection functions. After local government elections in 2000, the new political leadership of the city was less enthusiastic about devolving such significant control to the newly created utilities and feared the perceived political risk associated with these entities being unable to manage the city's services. Although the Service Delivery Agreement (SDA) signed in 2001 with JW agreed to transfer billing functions, the political unease regarding this scenario prevented the transfer of this critical function to JW. In effect, only the top 14 000 customers of the utility were transferred, giving JW control of only 30% of its revenue.

The inability of the company to control a larger proportion of its revenue base left it relatively powerless to address significant commercial losses resulting from poor data, erroneous billing patterns and high non-payment levels. These are issues that the company felt it could easily have addressed had it been granted greater autonomy in controlling same functions that are core to its business operations.

It was only after three years of operation that 60% of JW's customers were transferred from the city to the utility in order to enable it to perform meter readings, pre-edits of billing, credit control and revenue collection functions – as originally agreed to in the SDA.

Since 2009 however, the city has rescinded this position by centralizing billing processes undertaken by its UACs into a shared services centre. This has once again weakened JW's ability to control this function, resulting in increasing levels of NRW once again.

Transfer of delegated responsibilities allowed JW to implement various initiatives aimed at reducing commercial losses, ultimately contributing significantly to an overall reduction in NRW between 2004 and 2007.

Lessons Learnt

Corporatised utilities should be allowed to operate in an independent manner with sufficient control over those functions that are critical to their day-to-day operations, financial sustainability and overall performance, whilst the city (shareholder) retains control over key aspects such as approval of tariffs, setting of policy and holding the utility accountable for performance. The old adage that says responsibility should be delegated whilst accountability is retained finds great application in the relationship between the CoJ and JW.

Johannesburg Water as a corporatised entity was successful in reducing those components of NRW over which it had direct control, thereby demonstrating the strength of a more independent organisation in being able to create business, financial and operational efficiencies given sufficient autonomy.

Governance difficulties between the city and its 14 established UACs became apparent soon after establishment, greatly compounded by the lack of capacity of both the CMU and SHU to manage, monitor, regulate and service the tasks, activities and performance of all these organisations.

This was particularly evident given the mountain of data received on a monthly basis from the utilities as well as the need to provide reciprocal data to the UACs to allow them to operate optimally, as well as the need to regulate and set tariffs. The lesson learnt is that sufficient capacity should be created both at the utility and city level, in order to adequately manage the created relationship, assigned responsibilities and performance of each party. It is also critical that the expectations of each party towards the other be well communicated so as to avoid potential tensions, difficulties and misunderstandings

Project Highlights:

- [x] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [x] Employment Opportunity

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MBOMBELA LOCAL MUNICIPALITY

PUBLIC/PRIVATE PARTNERSHIP

Intervention Type	Institutional restructuring
Reason	Extended municipal boundaries incorporating large unserviced areas requiring large investments in infrastructure to enable service provision
Cost	Unquantified

The Mbombela Local Municipality (MLM) is situated in Mpumalanga and has transferred the provision of water and sanitation services to Sembcorp Silulumanzi (Silulumanzi) through a long-term concession contract. This represents the establishment of a Public Private Partnership commonly known as a PPP.

The PPP model, as it relates to the delivery of water and sanitation services, has been relatively successful throughout the world as a vehicle enabling the extension of services to the urban poor, whilst simultaneously creating greater efficiencies – especially in terms of reducing Non-Revenue Water (NRW) – in delivery of services to existing customers. Often the efficiencies created are the driving force that allow for the sustainable extension of services and this Case Study discusses the successes achieved by the created PPP in reducing excessive demand, water losses and Non-Revenue Water.

ISilulumanzi is responsible for servicing the areas of Nelspruit and the main Nsikazi townships of Kanyamazane, Tekwane, Msogwaba and Matsulu. Service coverage also extends to other peri-urban areas around these townships, such as Zwelisha, Mpakeni and Luphisi as shown in Figure 1.

The serviced area has a population of approximately 350 000 people living in 78 000 households.

Background

In 1996, due to the municipal demarcation process, the then Nelspruit Town Council (NTC) – now known as Mbombela Local Municipality – found its area of jurisdiction greatly increased, which also meant that the population to be served increased from about 30 000 people to 300 000. This brought about a situation in which the Council could not adequately finance the required new infrastructure and create the additional organisational capacity.

Figure 1: Silulumanzi service area

It was identified that these shortcomings would impact significantly on its ability to deliver services within its area of supply. In an effort to provide the much needed water services to all the people in the expanded area, NTC engaged in a Public Private Partnership (PPP) with the then Greater Nelspruit Utility Company (GNUC) – now known as Sembcorp Silulumanzi (Silulumanzi) – in 1999.

Overview of Public Private Partnerships

A Public Private Partnerships (PPP) is a long-term concession type contract between a public sector institution and a private company, in which the private company takes responsibility (and assumes all associated risk) for the funding, construction, operation and maintenance of required infrastructure over an agreed time period, normally in excess of 20-years.

According to the South African Government's definition, there are two types of PPPs: (1) the private party performs an institutional/municipal function, and (2) the private party acquires the use of state/municipal property for its own commercial purposes. A hybrid of the two types is also possible.

Payment can take the form of (1) the institution/municipality paying the private party for the delivery of the services, or (2), the private party collecting fees or charges from users of the service, or (3), a combination of both.
Given that a municipality might lack institutional capacity to deal with water and sanitation service issues, (including the management of NRW and the creation of efficiencies) entering into a partnership with a private party which has the management capacity and resources could result in great benefits.

Considerations

Since South Africa is a young democracy, its legislative and socio-economic environments are bound to change over time. This could have implications to a PPP concession contract and the conditions thereof, given that such contracts are long-term in nature and can be very complicated.

It is important to recognise these issues and ensure some flexibility in the contract to allow for a changing environment as well as ensure that the contract is unambiguous and easy to understand, especially for those individuals who will be required to use the contract in the future.

Objectives

Along with providing water and sanitation services to the urban areas of Mbombela Municipality, the contract set out targets that GNUC had to meet by 2009. These included:

- Reducing NRW to 15% in Nelspruit and 35% in all other areas,
- Reducing daily household water consumption to 0.5 kℓ in Kanyamazane and 0.6 kℓ in Matsulu, and
- Generally improving revenue collection throughout the municipal supply area.

Implementation

NTC implemented a 30-year concession agreement with the Greater Nelspruit Utility Company (GNUC) for the delivery of water and sanitation services to the urban areas in the municipal area, with any extensions to service delivery to especially rural areas, done on an ad hoc basis.

Figure 2: Head of Silulumanzi

GNUC was responsible for financing, maintaining, rehabilitating and improving municipal assets, metering and collecting water and sanitation revenue. Due to legislative regulations, the Municipality was responsible for the setting of tariff rates in consultation with GNUC, to ensure the recovery of operational costs and provision of an acceptable return to company.

As part of its efforts to reduce NRW, GNUC initiated 2 pilot projects, one in Matsulu in which the area was zoned and local unemployed residents were hired to research and disconnect illegal connections in each zone.

The other pilot was initiated in Luphisi, an area in which illegal connections were preventing 24 hour water supply to certain communities. The intervention involved communicating to community leaders the need to disconnect illegal connections and urging these leaders to influence cooperation by the community with disconnection initiatives.

Achievements

- Since 1999, Silulumanzi has succeeded in extending water and sewer networks to unserviced communities, with 94% of households now having access to some level of water service. This is an impressive achievement given the levels of growth in the number of households over the past 10 years. However, 68% of households receive an intermittent supply and do not have access 24/7,

- Satellite offices have been set up in the different supply areas to provide customer services such as payment kiosks, raising of queries and reporting leaks/water supply problems,
- A comprehensive asset register has been maintained and is linked to a GIS Master Plan and fault reporting/ repair system, which in turn is linked to customer billing and service level data,
- Through the two pilot projects, illegal connections have been uncovered, removed and household leaks repaired. This has led to the reduction of water wastage and a savings of 30 000 kℓ/month in the area of Matsulu,
- Over 8 000 non-functioning water meters have been replaced and a further 15 000 new meters have been installed throughout the municipal area. There is also an in-house training department which provides training to both staff members and communities in water matters including the importance of water supply and the management thereof.

Challenges and shortcomings

Significant changes have occurred in the contractual arrangements as originally agreed to in 1999, with the concessionaire (Silulumanzi) substantially reducing its responsibility for all investment in infrastructure. This has been made possible through the payment of grants to the municipality by national government for operating and capital expenditure.

Although the contract remains a concession in name, there is little doubt that the concessionaire has reduced and/ or limited its risk and responsibilities through the various renegotiations of the contract. The terms of the contract have been adjusted due to changing external circumstances.

Due to a shortage of skills and a lack of resources, contract monitoring by the MLM has been poor, resulting in a lack of progress in achievement of municipal objectives and targets.

In 2010, 68% of households still did not have access to 24-hour water supply, due mainly to a lack of capacity at the Kanyamazane Water Treatment Plant – which supplies a large part of the rural and/or peri-urban areas in Nsikazi. In addition, illegal connections on transmission main lines have prevented reservoirs from filling, contributing to the experienced intermittent supply. The concession company has not made much progress in addressing these problems, further exacerbating water wastage from household leaks and uncontrolled water use.

Progress in attaining targets that were set for the concession contract and addressing the chronic issue of illegal connections throughout the service area have been slow. Targets set for the reduction of NRW have not been attained and water demand has continued to increase.

Pilot programmes implemented by Silulumanzi to address wastage have shown success. However due to the lack of revenue potential that could be derived through implementation, no incentive exists for Silulumanzi to implement these pilots on a wider/larger scale.

No progress has been made in the provision of additional capacity at the Kanyamane Water Treatment Plant which would resolve the intermittent supply issues and meet the demand for water by residents.

The experienced problems have occurred largely because of a lack of oversight and accountability on the part of the municipality and a lack of dedicated effort by the Concessionaire to attain targets originally agreed to.

It is therefore imperative that a contract monitoring unit be set up so as to manage contract implementation and to hold the implementation agent to account for a lack of performance.

Lessons Learnt

Lessons learnt through the PPP process undertaken by the municipality are outlined below:

- PPP contracts should be kept as simple as possible due to their long-term nature and the high level of staff turnover,
- The need for strong and experienced contract management on the part of the Municipality is important in ensuring that the target communities benefit from the PPP contract and the private party meets the objectives of the Municipality,
- It is important to consider economic, political and social factors that can affect the PPP, especially in developing countries. Due to changes in legislation, policies, socio-economic and environmental conditions, the risk

assumed by Silulumanzi was reduced after the signing of the original contract, which direct negative implications to overall performance and achievement of agreed to targets,

- It is critical for the Municipality to clearly understand the affordability element associated with the PPP model and how targets set out in the PPP contract affect the cost of the providing services through a private company,
- It is important to ensure that sufficient capacity, in the form of personnel, financial resources and investments, be deployed in delivering services to communities through the PPP model, and
- Expectations and requirements of the PPP contract especially in terms of continued investment over the life of the contract, should form part of the contract and be strictly managed by the municipality.

Project Highlights:

- [ ] Verified Savings
- [ ] Behavioural Change
- [x] Political Endorsement
- [x] Capacity Built
- [x] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [ ] Scalability
- [x] Employment Opportunity

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BEAUFORT WEST LOCAL MUNICIPALITY

WATER RESTRICTIONS

Intervention Type	Water restrictions
Reason	Severe drought restrictions
Cost	Unknown

The Beaufort West Local Municipality (Beaufort West) is located in the central Karoo in the Western Cape and includes the towns of Beaufort West, Kwa Mandenkosi, Merweville and Nelspoort. Beaufort West has a population of 41 000 people with a high percentage of the residents classified as indigent.

The Western Cape had been experiencing the worst drought conditions in over 100 years which has had a significant impact on the region and its communities. Beaufort West's water resources, the Gamka Dam, had dried up and borehole water levels had dropped significantly. The municipality no longer had a sustainable water supply and had to implement severe water restrictions in an effort to significantly curb the water demand.

Water Restrictions

Water restrictions are measures undertaken by the relevant water authorities to restrict the demand for water by consumers in an effort to mitigate the risk of running out of water during a drought.

Water restrictions have to be implemented when the available water resources (rivers, dams and boreholes) are no longer able to support the continued levels of water abstraction. Restrictions are then implemented, monitored and enforced to ensure that water users comply with the measures. Water restrictions are, however, also an effective water demand management tool, albeit that they are often only implemented when resources are at critical levels and the water authorities are desperate to reduce the consumers' water usage.

Objective

To ration water consumption in order to extend the water supply from the existing stressed water resources.

Description

Water restrictions were initiated in Beaufort West in January 2010 by the Department of Water Affairs. The water restrictions, as implemented initially, required Beaufort West to reduce the volume of water abstracted by 40% and prohibit residents with private boreholes from abstracting groundwater for the irrigation of gardens between 07h00 and 17h00.

However, towards the end of 2010, the situation was dire with available water levels reaching critical levels. This prompted the municipality to implement further restrictions in the form of a shared savings scheme.
The municipal area was divided into 12 sections or zones, and each section, on a rotational basis, would have their water cut-off for 36 hours.

Municipal officials ensured that residents were well aware of when cut-offs would be implemented in the area. This allowed residents time to make alternative arrangements for the provision for water by filling up water bottles and buckets in advance ensuring that they did not run out of water needed for common household uses.
Furthermore, Beaufort West commissioned and installed water tanks at various points around the municipal area for

the purpose of providing residents with water during periods when their water was cut-off.

Results

Beaufort West experienced an immediate savings in water when water restrictions and the shared scheme were implemented. This also had a positive impact on the behaviour of the residents. The experience of having no running water changed their perspective of the need for implementing water conservation and water demand management practices.

Figure 1 below illustrates Beaufort West's total annual water abstraction for the periods 2006/07 to 2009/10.

The bars in the graph are representative of the abstracted volumes from each of the available water resources for each of the abovementioned periods.

The graph shows that during the 2009/10 period (red bar), there was significantly less water abstracted as a result of the implementation of water restrictions compared to the abstracted volumes during the previous periods (yellow, purple and blue bars).

Lessons Learnt

- Water restrictions can be an effective tool in controlling water demand and easing pressure on the depleted water resources. An added benefit is the influence the restrictions had on the perceptions of residents of the importance of water and entrenching a behavioural change towards water conservation and water demand management practices. What became overwhelmingly apparent to the residents of Beaufort West was the extent of a human's dependency on water when no more water flows out of the taps,
- Rolling out an awareness campaign to ensure that the whole community understands the need for water restrictions is an important part of helping residents understand the situation and avoid conflict with the residents when implementing water restrictions,
- Cutting off the water supply to the more affluent areas first helped the poorer communities realise that the impact of water restrictions would be felt by everyone and that it was not as a result of poor services or punitive measures because of lack of payment, and
- This helped to soothe any adverse reactions from the community. Beaufort West made every effort to identify all possible risks and mitigate any negative reactions that might arise as a result of the water restrictions. Due to their foresight, they were able to implement the water restrictions successfully which helped carry the community through the drought period and ensure that there was a continual supply of water.

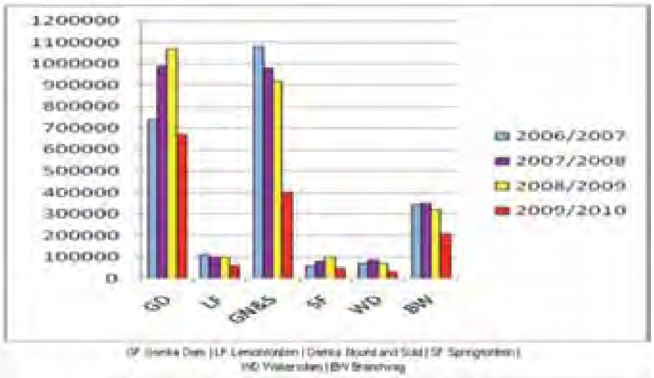

Figure 1: Water levels in boreholes

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [x] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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BEHAVIOURAL CHANGE

Programmatic approaches to water demand management should include initiatives that are aimed at modifying behaviour of the end-user towards water and water use. This is even more critical within the national context relating to water stress and future scarcity.

These could include changing attitudes towards water and its perceived value, changing habits relating to water use, encouraging the use and uptake of alternative technologies that can lead to water savings as well as education and awareness campaigns. These are in addition to interventions aimed at transferring ownership of plumbing fixtures and consumption to the end-user such as improved metering and billing, which have been addressed in previous sections of the compendium.

A selection of case studies that document successful approaches to behaviour modification are presented in the section below. These include public campaigns, customer education drives, individual metering as opposed to bulk metering of apartment buildings and rainwater harvesting.

KNYSNA LOCAL MUNICIPALITY

B01

PUBLIC WATER SAVINGS CAMPAIGN

Intervention Type	Public campaign
Reason	Due to severe drought conditioned, behavioural change was necessary in order to conserve water
Cost	Not made available

As the drought persisted in 2009, considered to be the worst in the Southern Cape in 132 years, the Knysna Local Municipality (Knysna) was required to reduce its water abstraction by at least 30%. This would require the average household water consumption in the area to be reduced from 24 kℓ/month to 15 kℓ/month.

Reasons

Knysna had to respond quickly to conserve water and to protect the limited available stored raw water. The Karatara River, which supplies Sedgefield, had already stopped flowing on 2 February 2009. The Akkerkloof Dam, which supplies the town of Knysna, had a reserve of only 20 days left. A Public Water Savings Campaign was identified as the quickest WC/WDM intervention that the Municipality could implement that would lead to an instantaneous reduction in water consumption.

> "When the well is dry, we learn the worth of water"
>
> *-Benjamin Franklin*

Objectives

There was a need to stimulate a change in the behaviour or attitude of the residents and the industrial sector to implement efficient water consumption. A public awareness campaign would highlight the scarcity of water and the need to conserve this resource. Knysna set quantifiable targets which would require both households and businesses to achieve. These targets have been listed in Table 1, below.

Table 1: Water Savings Targets

Raise public awareness of the water scarcity and the need to conserve this scarce resource,
Reduce consumption to a target of ±75 ℓ/person/day, Reduce Total Average Water Consumption for Sedgefield to 1 Mℓ/day,
Businesses are to reduce water consumption by 30%, Optimise the use of greywater, and
Raising the awareness as how to use water efficiently.

Objectives

Knysna decided to use a combination of strategies to emphasis its water savings campaign message in the most effective way. These included:

- Erecting 14 billboards on Knysna's most popular beaches and routes,
- Distributing pamphlets containing water savings tips,
- Issuing each household and business premise a package containing consumption audit forms (to identify areas, within the home or business, where water usage could be reduced) and Hippo Bags (a plastic bag that is filled with water and placed in the toilet's water cistern reducing the amount of water used with each flush),
- Water savings notices that had to be placed at all water usage points by businesses on their premises,
- Issuing of notices to residents and businesses updating the customer about their current water use, the required target for water consumption and where they ranked in terms of their consumption comparing to the highest to lowest water consumption,

- Vehicles driving around the municipal area with loud-hailers broadcasting the extent of the water shortage and reminding residents and businesses how to save water, and
- Visiting schools, and through an education programme, raising awareness amongst learners with the goal of effecting further behavioural change of the learner's parents.

Achievements

The Water Savings Campaign had an impact on the behaviour within the community creating a new water consumption culture. The Knysna residents responded well to the information passed on to them and were fully supportive of the need to conserve water.

Many of the residents started implementing water savings initiatives of their own in their homes such as installing rainwater harvesting systems and water demand management devices. As a result the campaign achieved a water savings of 39% enabling the Municipality to maintain a sustainable water supply even under extreme drought conditions.

Lessons Learnt

The experiences gained through the implementation of the public awareness intervention included:

- Drought management by-laws needed to be put in place as part of the Municipality's disaster management plan to ensure that drought situations would be managed quickly and effectively,
- Capacity or the contingencies to make such capacity available in the event of a drought for a dedicated team to enforce drought management by-laws,
- Capacity has to be increased, especially specialising in standby staff, to immediately address water losses as a result of water system failures (such as burst pipes, etc.),

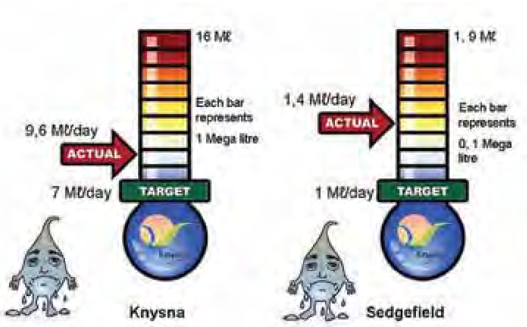

Figure 1: Water use and water use targets on billboards in Knysna

- Customer water consumption database has to undergo a stringent analysis to identify high water consumption by consumers and other discrepancies such as problems within water supply zones, the ring-fencing of zones and tariff and step-tariff allocations which in Knysna's experience when rectified also resulted in improved revenue collection and further lowering of water consumption,
- WC/WDM Municipal forums that cut across the different departments within the Municipality resulted in better understanding of the responsibilities and contributions that could be made by all Municipal officials in all the departments,
- The installation of back-up tanks in the residential areas by the Municipality had a direct impact on the attitude and behaviour of the community (the piped water supply was to be cut-off as the drought intensified and the water tanks would supply only drinking water that would have to be collected by residents with containers), and

Figure 2: Banner at Buffalo Bay beach

- Customer water consumption database has to undergo a stringent analysis to identify high water consumption by consumers and other discrepancies such as problems within water supply zones, the ring-fencing of zones and tariff and step-tariff allocations which in Knysna's experience when rectified also resulted in improved revenue collection and further lowering of water consumption.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [ ] Scalability
- [x] Employment Opportunity

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B02

BAVIAANS LOCAL MUNICIPALITY

WATER AWARENESS PROGRAMME

Intervention Type	Behavioural
Reason	Due to severe drought conditions, behavioural change was necessary in order to conserve water
Cost	R40 000.00/year

The Baviaans Local Municipality (Baviaans), which includes the towns of Willowmore and Steytlerville, is located in the Karoo in the Eastern Cape. Baviaans has a population of 16 500 (9 900 impoverished) residents. The municipality extracts 1 700 kℓ/day from groundwater and surface water sources of which 20% is lost.

The Eastern Cape has been experiencing the worst drought conditions in almost 50 years. This has left many of the surface water resources dry and the extraction from boreholes has had to be extended. This has prompted municipalities in the province to review their available water resources and implement water conservation and water demand management (WC/WDM) strategies. Baviaans also had an increase in water demand due to higher temperatures during the summer period, adding further stress to their available water resources. A multi-pronged approach was undertaken by the municipality which included an intensive water awareness campaign.

"When the well is dry, we learn the worth of water"

-Thomas Fuller

Water Awareness Campaign

An awareness campaign is an approach that can be used to highlight a potential catastrophe in an effort to effect a behavioural change that will avert a disaster. Baviaans had to highlight the high demand for water use and wastage to avert a water shortage by changing people's perceptions of water usage and reduce water consumption. Awareness campaigns can be done through various activities such as national water weeks, competitions with sponsorships through the media and by marketing.

Marketing can be conducted through various mediums including radio, television, advertising boards, pamphlets and road shows which involve officials giving presentations on WC/WDM within communities and schools. Effective campaigns need to disseminate information that is relevant, understandable and community specific to ensure that the message of WC/WDM has a sustainable impact on the targeted audience. It is imperative to note that awareness campaigns are not an isolated tool in dealing with water-related issues, but rather form part of the WC/WDM strategy to address water issues.

Objective

To undertake a water awareness campaign to inform the community about dam and borehole levels, water consumption data and other pertinent water related issues.

Description

In the case of the Baviaans community, passing on vital information concerning the status of water resources and its use was an important task for the municipality to undertake. Municipal officials wanted to ensure that the residents understood the severity the drought situation had on water resources and the need to change water usage behaviour in order to ensure a sustainable water supply during the drought. Baviaans decided to make announcements around the municipal area with a vehicle fitted with loud hailers, while at the same time, distribute weekly pamphlets to community members with information on saving tips, water consumption statistics and dam levels.

High water consumers were identified and allocated a quota on the amount of water that could be consumed on a monthly basis. An example includes a limit of 30 kℓ/month that was placed on a nursery in the area. On a weekly basis, Baviaans would give pamphlets to high water consumers with the aim of informing these customers of their targeted water consumption and their performance relative to this target.

High water consumers such as schools, nurseries, police stations and hospitals were also closely monitored by the municipality to ensure that they complied with the restrictions. In exceeding this quota, the customer would first be given a notice stating that their quota had been exceeded with proof of their meter readings, after which, if the customer continued to exceed their quota, fines were then issued as a punitive measure.

Results

Baviaans has seen a notable change in water use behaviour in the area. Residents have been willing to assist the municipality in their efforts to conserve water by changing their perspective on the importance of water and its conservation and implementing water savings tips. This has helped the municipality in ensuring that water supply to the community has continued and that there would be future water resources to meet the community's demand requirements.

Lesson Learnt

- An awareness programme plays a critical role in an effective WC/WDM strategy. From this case it can be seen that even a low-keyed water awareness campaign has a significant impact on the behaviour of resident's water consumption practices,
- There is a need to understand the effect prevailing conditions could have on water resources,
- Commitment from municipal officials is needed,
- It is important to ensure the community is constantly aware of the municipality's water status,
- Although the need for a water resources and catchment area policy was identified, the development of specific measurable outcomes in the policy and implementation of the policy is poor making the policy a paper exercise,
- The need to build capacity and institutional arrangements within the municipality to address WC/WDM was recognised by the municipality, and
- The existence, albeit with a low ranking municipal official, of a champion with the commitment and dedication to drive the campaign is seen as being critical in leading to a successful water savings programme.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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B03

CITY OF CAPE TOWN METROPOLITAN MUNICIPALITY

PROMOTION OF GREYWATER USE

Intervention Type	Consumer education
Reason	Reducing the demand for water
Cost	Unknown

The City of Cape Town Metropolitan Municipality (CCT) is home to 3.4 million people with a daily demand of 800 000 kℓ of water. With the growth of the city as it currently is the demand for water is going to exceed the available capacity of the water resources in 2017. Furthermore, climate change is now an added factor and is probably the main reason for the increased frequency and severity of droughts in the Western Cape.

A climate change strategy and action plan was drafted for the Western Cape by the Department of Environmental Affairs and Development Planning in the Western Cape in 2007. This report identified that the No. 1 key outcome should be to establish a cohesive Water Supply and Infrastructure Management Programme that would fully incorporate the identified climate impacts and risks. The implementation of Water Conservation/Water Demand Management (WC/WDM) interventions in the CCT has become crucial to the sustainability of its growth and development. As part of the CCT's existing WC/WDM strategy it has implemented, amongst a number of other WC/WDM interventions, a programme to encourage the use of greywater in households.

> 'It's madness that you stand in the shower and see this resource go down a drain that eventually goes to an ocean outfall and pollutes our oceans"
> *John Grimes*

Greywater Systems

Greywater is sourced from the bath, shower, bathroom sink and washing machines (but only where environmentally friendly laundry detergents are utilised) and is used for irrigation purposes. Consumers can also consider redirecting some of their greywater for the flushing of the toilets.

A greywater system is made up of an interconnected network of pipes from a house, a filter, a pump and sprinklers which drain the greywater from different sources in the house to be used in the garden.

Research has shown that the sulphates and nitrates found in the residues and soaps in greywater are beneficial nutrients for plants.

However, water from the kitchen sink should not be included in the greywater due to its high solid content and undesirable chemicals which can have a negative impact on the environment.

Greywater systems thus present an alternative source of water that can be used by household consumers for irrigation purposes and to flush toilets. This significantly reduces the demand for potable water as the water used for garden irrigation makes up approximately 35% of total household water consumption and toilets use between 7 and 9 litres of water per flush. As a result, the use of the system will aid in the efforts in conserving raw water resources and it is for this reason the CCT sees it as imperative to promote the installation of these systems.

Objectives

The main objective was to promote the installation of greywater systems by household consumers in an effort to reduce water demand by consumers, thus conserving scarce water resources and ensuring the sustainability of the water supply in the future.

Description

The CCT does not have a formal project in which it installs greywater systems or a by-law enforcing the installation of the systems in the city. However, through the roll out of awareness campaigns which includes the handing out of pamphlets, putting up posters, the annual water week event, and as well as at community events, the use of greywater, through the installation of greywater systems in households, is being promoted. Pamphlets and posters distributed throughout the City provide general information on water savings tips and include information on greywater systems.

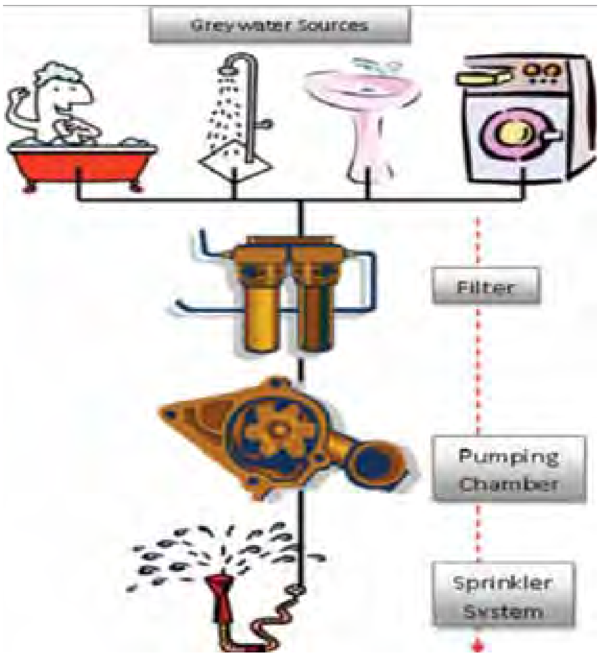

Figure 1: Greywater process

This includes the definition of greywater, how the system works, what greywater can be used for and how to use the system properly to ensure that the environment is protected and the health of the city's residents is not compromised. Individuals seeking additional information on the system are able to contact the municipality where they are then referred to a service provider. It is hoped that through the installation of greywater systems that the water savings achieved would aid in the combined WC/WDM efforts to reduce the city's demand for water ensuring sustainable supply of water.

Results

The CCT states that over 1 000 households in the City have already installed greywater systems. On average, a household of 4 people uses 0.7 kℓ/day of water supplied and the city. If 35% of this water, normally (used for irrigation, is not sourced directly from the municipality's network, but is greywater, water used for the irrigation of the home's gardens), it is calculated that a savings of 246 kℓ/day of water can be achieved by these 1 000 households.

These figures are seemingly not significant if 25% of the potentially 904 000 houses in the greater Cape Town area were to each achieve a savings of 0.25 kℓ/day. This would represent a 7%/day saving of the water abstracted by the CCT to supply Cape Town with water.

In other words, the water that could be saved per year if only 25% of the households in the CCT were to use greywater is equivalent to 26 days of water supplied to Cape Town.

Greywater use has also reduced the volumes of wastewater at the wastewater treatments plants. This will in the long term have a significant positive impact on the financial implications for the need to upgrade the wastewater treatment works.

Lessons Learnt

- There should be an awareness of the potential health and environmental risks associated with the use of grey water,
- Formal policies and standards which regulate the installation and use of greywater systems should be put in place to mitigate and manage the potentially negative impacts on the environment and individuals,
- There should be a multi-pronged approach, using various mediums to raise awareness of water conservation, convey understanding on the importance of installing a greywater system and must reach as wide an audience as possible. Media which have been successful in engaging communities include street theatre, street

competitions, simple colourful pictorial posters to be hung in the household at the point of use and simple colourful pamphlets for residents to keep handy as ready sources of information. Local sources of reasonably priced hardware for maintenance of structures and systems and community-based facilities for immediate problem solving are also excellent places to convey the message,

- Communicate the message in a language suitable for the targeted market,
- Ensure that the user understands how to properly use a greywater system and understands the health and environmental risks of the wrong use of greywater. Failing to do so can result in the deterioration of soil quality, reduce the ability of plants to grow, and spread disease,
- A greywater system reduces the use of potable water thus bringing about water savings. Less water needs to be pumped from the already stressed water resource which ensures the sustainability of future water supply, and

Figure 2: Greywater system

- Financially, both the consumer and the municipality benefit as costs decrease due to the reduction in water supplied and consumed. Pressure on the need to upgrade the infrastructure such as treatment plants is also reduced.

Project Highlights:

- [ ] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [x] Capacity Built
- [ ] High Level Management
- [x] Cost Effectiveness
- [ ] Replicability
- [x] Scalability
- [x] Employment Opportunity
- [ ] Verified Savings
- [x] Behavioural Chnage

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B04

CITY OF TSHWANE METROPOLITAN MUNICIPALITY

INDIVIDUAL METERING VS. BULK METERING

Intervention Type	Individual Metering vs. Bulk Metering
Reason	Due to severe drought conditions, behavioural change was necessary in order to conserve water
Cost	Not made available

As the drought in the 1980s continued unabated, the City of Tshwane Metropolitan Municipality (CTMM), then Pretoria Municipality, was forced to implement different Water Conservation/Water Demand Management (WC/WDM) interventions to reduce the city's overall water consumption. One of the actions taken by the city was to implement a stepped-tariff system as a punitive measure in the hope that it would bring about a change in behaviour.

"Filthy water cannot be washed."

– West African Proverb

The system was designed to charge a lower tariff for "reasonable" consumption and a higher tariff for "excessive" consumption. Based on the water meter's readings, households with high levels of water consumption were going to be faced with high water accounts. However, blocks of flats or apartments have a single bulk meter which measures the total water consumption for the whole block of flats. The owners or the corporate body simply shared the cost of water between the individual units. Households that were not reducing their water consumption were then not feeling the full impact of the stepped-tariff system. Furthermore, because of the high number of blocks of flats in the Pretoria area, the city was not reducing its overall water consumption as expected.

Reason

When comparing the water consumption of bulk-metered complexes, specifically apartments or blocks of flats, the water consumption levels did not decrease as was being achieved with standard individually metered free standing residential units (houses). The Municipality analysed the monthly bulk meter readings (over a 12 month period) of the 1 213 apartment blocks in the city and found that 51% of the water consumed by all these apartment blocks was in excess of the prescribed quota of water.

The main reason for the difference in reduction in levels of water consumption between houses and flats could only be accredited to the fact that houses were individually metered and blocks of flats had a bulk meter. The City then decided that individual meters should be installed for each separate dwelling in each of the blocks of flats so that the individual units would be forced to take responsibility for their own water consumption.

Table 1: Indoor water use in flats and houses

City	Sample Size (No. of persons)		Indoor water use (ℓ/capita/day)		Occupants per dwelling unit	
	House	Flat	House	Flat	House	Flat
Nelson Mandela Bay Metropolitan Municipality	351	207	148	176	4.4	1.90
City of Tshwane Metropolitan Municipality	76	2 268	154	224	4.0	2.17
Mangaung Local Municipality	128	45	145	270	4.1	1.45
Complex of Flats in City of Tshwane Metropolitan Municipality						
Kiowa (Block A Bulk metering)		83		170		
Kiowa (Block B Individual metering)		83		130		

The CSIR with the CTMM implemented a project to analyse the impact on water consumption levels if a meter was installed in each of the units of a block of flats where previously there was only a bulk meter.

The CSIR study also took into consideration the water consumption of blocks of flats in other municipalities to better understand water consumption in these types of dwellings and to try and ensure that the local anomalies were not a factor in the investigation.

Objective

The objective of this WC/WDM intervention was to determine to what extent the installation of individual meters would have on a change in behaviour towards water consumption of individual households in blocks of flats. However, the process had to firstly, determine to what extent, and define why, the per capita water consumption of flat dwellers differed to that of individual stand-alone residential units of a similar income group, and secondly, the pros and cons of implementing a programme to install individual meters for each dwelling unit within a block of flats.

Description

Traditionally water consumption of houses has been seen, because of water uses such as gardening and the filling of pools, as an obvious focus where water demand management interventions or water restrictions can be implemented to reduce the municipalities demand for water. With flats the assumption has been that there is little scope for significant water savings. However, this investigation found evidence that water wastage by occupants of flats is high. Table 1 illustrates that the water consumption per capita for houses is lower than that for flats.

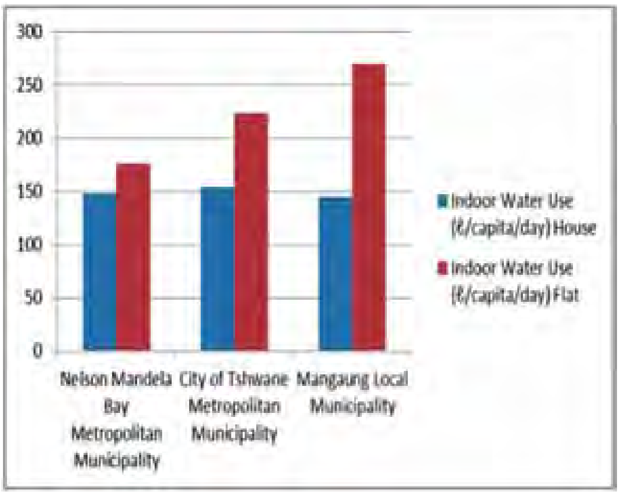

Figure 1: Water consumption of houses vs. flats (from table 1)

Figure 1 illustrates that the water use per capita is higher for people living in a flat as compared to people living in a house (when taking into consideration only indoor water use). However, it was found that because houses have higher occupancy levels (families occupy houses compared to flats which is more likely to be occupied by a single person, couples without children or two people sharing) and because there are common uses of water that are spread amongst people in the same dwelling for example, kitchen use, laundry, washing of the floor, the consumption of water per capita by a resident of a flat is higher than that of resident of a house.

This same trend is reflected in the occupancy levels in flats as can be seen in Table 1. This type of water usage level, as would be expected, will be difficult to reduce in flats because of the lower number of occupants when compared to houses with a higher level of occupancy. But Figure 1 also illustrates that the water consumption per capita of houses in the different areas is similar but the water consumption of flats where bulk metering is being used varies quite significantly.

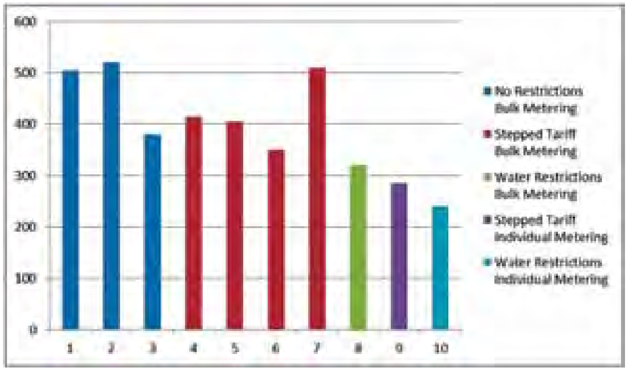

Figure 2: Water consumption levels (ℓ/day/unit) for flats

Following this initial investigation a twin set of blocks of flats were identified in the city, with 50 units in each block, which was considered an ideal situation. One block of flats could have individual meters installed in each of the 50 units while at the other block of flats the bulk meter could remain in place. The water consumption of each of the individual flats could then be monitored in the one block and compared to the water consumption of the other block of flats which has the bulk meter. In order to ensure that a comparative set of results was obtained that could also be compared to the water consumption of houses, an agreement between the flat dwellers and the Municipality was negotiated so that the individual meters were read by the Municipality. The occupants would receive a combined water/electricity bill similar to that received by an individual stand-alone unit.

Achievements

In flat complexes where bulk metering is used and the water consumption for the whole complex can only be recorded, there is no focus on an individual's water consumption. Thus the significance of the wasted water, when spread over a large number of users, becomes insignificant. However, when all the units are wasting water, the water consumption of each unit and for the whole block of flats becomes significant. The old problem of, "I cannot be held accountable" comes into play and everyone wastes water.

This level of water wastage is further intensified where water piping is hidden away in service ducts which in turn drain directly into the sewer or storm water systems, hiding leaks and giving the perception that the complex is well-managed in terms of water losses.

Columns 1 to 3, as illustrated in Figure 2, are blocks of flats where there are no water restrictions and the water consumption is measured with a bulk meter. The water consumption for these flats is over 500 ℓ/apartment/day.
Columns 4 to 7 represent flat complexes in areas where stepped tariffs have been implemented, and even though there is no individual metering (only bulk metering) the water consumption has been reduced by between 80 and 150 ℓ/apartment/day.

Column 8 shows the level of water consumption of bulk metering in an area where there are water restrictions. The data represented by columns 1 to 8 shows a definite reduction of water consumption where some form of WC/WDM intervention has been implemented even though the users are only monitored by a bulk meter.

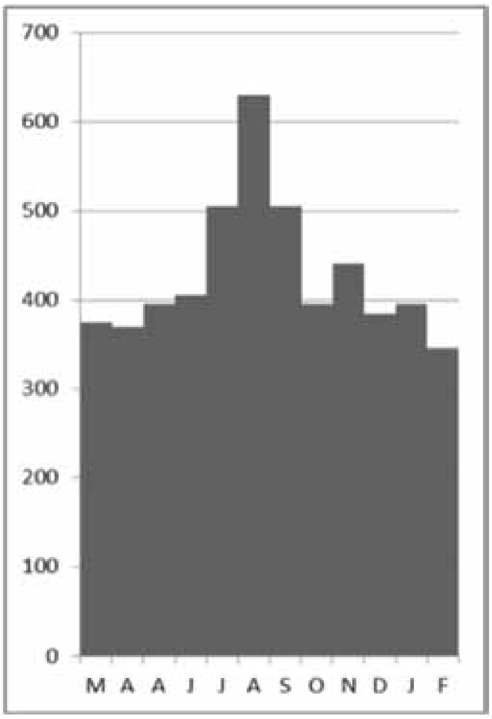

Figure 3: Water consumption bulk metered flats (average ℓ/day for the month)

The exact interpretation of why this may be the case is unclear except that the water demand is influenced by these interventions or, as in these cases, due to water restriction public awareness campaigns people in general are more careful with their use of water.

However, columns 9 and 10 show significant lower water consumption in flat units which are individually metered albeit that there are other WC/WDM interventions that were implemented at the same time that would have had an influence on the water consumption.

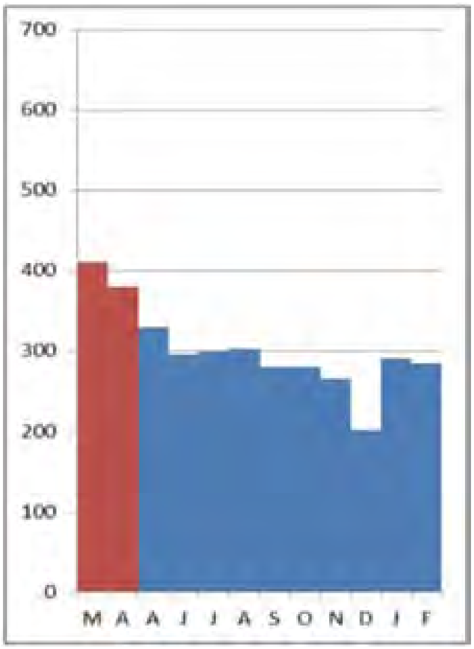

Figure 4: Water consumption for individually metered flats (average ℓ/day for the month)

The installation of individual meters as compared to bulk metering for flats in a multi-dwelling complex definitely identifies the water-wasters who otherwise, under a bulk-metered system, would have remained unknown. Individual metering and billing highlights the existence of leaking water fittings in multi-dwelling complexes, and motivates the tenants to attend to them. The saving in water consumption achieved in multi-dwelling complexes with individual metering and billing is between 20 and 30% of the former bulk-metered consumption.

Lessons Learnt

In reviewing possible options to implement individual metering, it was found that to retrofit most blocks of flats with individual meters to each flat with access to water piping was virtually inaccessible, and that in most cases individual flats were supplied from more than one point.
One of the initial results of introducing individual metering was the identification of points at which water was being wasted. The caretaker also reported that only two to four of the flats exceeded their quota on a monthly basis. In one case the bulk metered flats showed that the consumption was generally below quota, however in July a serious leak developed in the service pipe and by the time is was

discovered and repaired the consumption quota had been exceeded for the months July, August and September.

Figure 3 and Figure 4 illustrates the difference in the water consumption of the bulk-metered flats and the individually metered flats (the first two months is representative of the water consumption when the block of flats' water consumption was bulk-meter measured.)

It was also found that tenants of individually metered flats prefer this system to bulk metering.

The provision of individual meters would result in a cost to the local authority which will not be recovered because the revenue received from the water consumption measured by the bulk metering has already been accounted for, and individual metering would reduce the revenue by water consumption.

Different residential environments, the number of people in those environments, all have an influence on the water consumption per capita. As occupants in flats do not pay directly for their water consumption or do not have a way to measure their water individually, the consumption of water in a complex or block of flats is seen "as somebody else's problem".

Water restrictions and stepped tariffing systems definitely have a limited effect on controlling water consumption in bulk-metered apartment complexes, but the end-result is that by increasing the cost of water, water savings are achieved. This may, however, not reflect in revenue received from the consumer.

Water reticulation systems in blocks of flats are hidden and housed in separate service ducts within a building and discharge directly into storm water systems or the sewer and leaks or pipe bursts are not visible and may occur over long periods of time before being repaired.

Limitation of Individual Metering in Blocks of Flats are:

- If the meter is near the flat, there is no space for or access to the meter,
- Meter readers must have access to and enter the building and must go up and down steps,
- Long individual pipes between the meter and the flat increase building and maintenance costs,
- The practicality of retrofitting buildings with meters in most cases was found to be virtually impossible because of inaccessibility and as often is the case each flat is supplied from more than one point,
- Rentals and levies have to be reduced and readjusted which has an impact on occupancy contracts, and
- Responsibility and ownership of the piping/network within the building between the main water supply of the municipality and the meter becomes ambiguous.

Implementing individual metering of flats will involve extra expense, which will ultimately be for the consumers account, these include:

- Water Meters. The purchase and installation of the meters and any inspection box or duct needed to house the meter involves the greatest expense,
- Although some of this expense may be borne by the municipality it does have an impact on the costs, and
- Meter reading which depends how it is implemented which includes processing readings, billing and revenue collection. Although this cost is borne by the local authority, it could be done by the complex management.

The retrofitting of water meters in existing apartment buildings is generally impractical, however, it is imperative that building regulations and the process for the approval of building plans and supply of services should insure that new building apartments and other types of complexes include metering for individual metering.

Project Highlights:

- [x] Verified Savings
- [x] Behavioural Change
- [ ] Political Endorsement
- [ ] Capacity Built
- [ ] High Level Management
- [ ] Cost Effectiveness
- [x] Replicability
- [x] Scalability
- [ ] Employment Opportunity

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WATER RESEARCH COMMISSION

B05

IKWEZI LOCAL MUNICIPALITY

PROMOTION OF Rainwater HARVESTING

Intervention Type	Consumer education
Reason	Scarce water resources
Cost	R1.9 million

Water Conservation and Water Demand Management (WC/WDM) is the responsibility of municipalities to ensure that water is used efficiently to "safeguard" the "capacity" of South Africa's threatened water resources. Unless our behaviour towards the way we use water is changed, water demand will eventually exceed water supply. By municipalities encouraging rainwater harvesting, they are changing the behavioural pattern of water consumers and decreasing the pressure of the municipality's demand on water resources. Rainwater harvesting is the action of collecting rainwater which would under normal stormwater management practices be discharged and "lost". The Ikwezi Local Municipality (Ikwezi) which includes the towns of Jansenville, Klipplaat and Waterford is situated in the Karoo, an arid area, which is prone to prolonged drought conditions with an average rainfall of only 300 mm/year (compared to South Africa's average rainfall of 464 mm and the world average rainfall of 860 mm).

> "Over recent years water costs, combined with sewerage rates, have escalated far faster than inflation. This means that it has become worth the while to install rainwater harvesting systems."
>
> *-Water Rhapsody*

Rainwater Harvesting

Rainwater harvesting is the collection and storage of rainwater from rooftops. This is also a Schedule 1 permissible use of water, as included in the National Water Act, 1998 (Act 36 of 1998) which grants anybody the authority to collect rainwater off a roof (not off paving, or run-off from any other type of surface).

> In South Africa WC/WDM is defined by the Department of Water Affairs' (DWA) WC/WDM strategy as: "The adaptation and implementation of a strategy by a water institution to influence the water demand and usage of water in order to meet any of the following objectives, which include, economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services, and is political acceptability

Although rainwater can be harvested from different types of surfaces in most cases rainwater is collected via existing gutters and downpipes and is then diverted to a storage tank The water is then used directly from the tank for common household tasks such as dishwashing, flushing toilets or washing clothes, irrigation of gardens and for fire fighting purposes.

More intricate rainwater collection systems include the filtration of the water collected, to remove unwanted debris, and connections to different household water use points with the use of a pump. When there is a demand for water in the house the pump automatically switches on and draws water from the tank. These types of systems can also be set that as soon as the rainwater storage tank is empty a valve is opened and water from the municipal mains then supplies the household.

WC/WDM purists do not generally view rainwater harvesting as a WC/WDM intervention. However, within the context of the municipality consumer supply demand relationship, rainwater harvesting is an intervention that reduces the demand for water by the municipality from their available water source.

Rainwater harvesting is unique in that it is the collection and storage of water at the point of use. Thus the need to upgrade the municipality's water supply network to supply an area with water or to accommodate growth is now not needed.

This intervention, therefore, supports DWA's definition for WC/WDM where the rainwater harvesting is the implementation of an initiative by a water institution which will achieve an improvement in economic efficiency, social development, social equity and a political acceptable sustainable supply of water and services.

Further rainwater harvesting reduces the need to import water from neighbouring catchments which are also stressed and water authorities have to build ever increasingly bigger water augmentation schemes to supply more and more water.

Rainwater harvesting, however, effectively utilises the water in the catchment in which it originates. The storing and transporting of water from one country to another is now considered internationally as an unacceptable practice. This is also a concern between catchments in one country.

Rainwater harvesting offers as an alternative, quick cost effective water supply option to isolated communities in water scarce areas. This is particularly suitable in rural areas with a dispersed population and where a reticulated water supply is not feasible or is an extremely costly investment. The low cost of the rainwater harvesting technologies are a more attractive investment option in rural areas.

Objective

To supply water to households of a good quality by installing tanks for rainwater harvesting because of the lack of capacity to address:

- Bulk demand (local network systems, imported from another catchment, and a dam that needs to be built),
- The poor quality of local groundwater, and
- The high levels of water wastage by consumers (when consumers are in control of their own water collection they are more careful of not wasting water).

Description

Ikwezi LM is one of the first municipalities to implement a wide scale rainwater harvesting project to provide indigent households with access to water. Households were fitted with rainwater tanks, taps and catchment kits which included gutters and downpipes. The project, now about to move into its fourth phase, has seen the delivery and installation of over 1 800 rainwater systems (which include a tank and catchments kits).

Figure 1: Water tank used in harvesting rainwater

Lessons Learnt

- Rainwater harvesting is only seen as a short-term intervention. Authorities and communities should view rainwater harvesting as a viable option and also learn to live within the constraints of their environment and not consider piped water as the only "real" water supply option,
- To supplement or increase water supply volumes additional rainwater collection "technologies" could be considered including additional roofs, paved areas and increasing storage capacity with additional water tanks,

- Rainwater harvesting is:
  - Cost effective in terms of water supplied versus capital investments made,
  - Suited to rural communities far from available water resources,
  - Ideal for areas where there is a groundwater quality problem, and
  - The services can be implemented in a shorter period ensuring a quicker supply of water.
- Albeit it that the rainwater harvesting intervention in Ikwezi was a success and even though there have been prolonged droughts in the area WC/WDM is not included in the IDP. The Ikewzi municipal officials are not considering alternative options to bulk water supply from a dam. This is contrary to the fact that the collection of rainwater in Ikwezi LM improves the supply of water, the quality of water supplied is better and there is a supply of water to more households without having to upgrade the existing water supply network,
- In 2009 the government set aside R67 million just to address the water supply-drought related issues in Ikwezi LM alone. R60 million was budgeted for bulk supply upgrades compared to the R2 million spent on rainwater harvesting,
- Ikwezi LM is located in a hot arid area where a large percentage of the rainwater, if allowed to flow into the environment, would be lost due to evaporation or to groundwater. Therefore, rainwater harvesting is the efficient use of water in an economically efficient and prudent manner, and
- Groundwater in the Ikwezi LM area is not of an acceptable quality for domestic purposes. The water is highly saline and is not palatable. The groundwater, however, is the only available source of water in the area and people in the Karoo have grown up with the taste of the "Brakwater" (salty water). Therefore, by collecting the water, it is used before it filters through soil and rock (making it salty) and enters into the groundwater resource from where it is abstracted.

Project Highlights:

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CONCLUSION

A key challenge in planning for future economic growth and social upliftment in South Africa is ensuring efficient use of water supplies and reducing water consumption through improved management of demand for water. This notion also recognizes that the eradication of poverty cannot take place without water.

Historical demand for water continues to grow across the country and unless steps are taken to reduce demand, especially given that South Africa faces water scarcity in the near future, water shortages will become the order of the day.

Case Studies documented in this compendium abundantly demonstrate that it is possible to reduce water demand of municipal customers through carefully managed interventions, and in so doing also achieve greater financial efficiency, reduce Non-Revenue Water and improve operation and maintenance procedures.

It is often argued that WDM can hamper economic growth and development, and whilst this may be partially true for a punitive type approach adopted in a crisis situation such as a prolonged drought, it is untrue for a properly planned and targeted WC/WDM strategy that aims to reduce demand through the creation of efficiencies, elimination of water losses in supply networks, reducing wasteful use of water consumers, improving institutional capacity, as well as changing perceptions and human behaviour of especially end-users. Presented case studies provide proof that efficiencies can be created whilst development is maintained. Service delivery can be expanded whilst ensuring sustainability of existing operations, and that water demand management can provide opportunities for economic growth and the generation of employment.

Case studies also show that municipal WDM is not just about reducing the demand of middle to high income consumers and thus impacting on the ability of the municipality to generate revenue through water sales. Additionally the use of water tariffs as the only tool to manage WDM may not necessarily be practical. Rather WDM measures should be focused on a broad range of interventions that aim to create a culture of efficiency and enhance the value of water in the mind of the end-user.

RECOMMENDATIONS

Having completed the assignment, the following recommendations relating to especially future research work and expansion of the compendium are made:

- Although more than 110 projects, programmes, initiatives and interventions were identified during the data collection phase of the project, the lack of qualitative and quantitative information made available to the research team reduced the number of case studies that could be included in the compendium to 40. Future research work and revisions of the Compendium should focus on capturing additional data and case studies into the compendium to allow for inclusion of additional studies and completed work,
- Ideally the compendium should be updated every few years to allow for inclusion of updated results, especially as in terms of on-going multi-year projects and new work undertaken by the municipalities,
- The Terms of Reference for the compendium provided for the documentation of case studies at the municipal level. Water demand is also being managed by other tiers of government and other water use sectors such as agriculture, mining and industry. Our recommendation is that future research work be broadened to include demand-side management by other sectors, other governmental departments, bulk water suppliers and other entities/organizations involved in Integrated Water Resource Management. Documentation of work being undertaken by NGOs and Non-Profit Organizations should also be included,
- Subject to participation and support by appropriate organizations representing the Southern Africa Development Community (SADEC) region, the compendium could include WDM measures and projects completed in other southern African countries.