Energy Efficient Cities Initiative

GOOD PRACTICES IN CITY ENERGY EFFICIENCY:

Emfuleni Municipality, South Africa - Water Leak Management Project

Project title	Sebokeng/Evaton Pressure Management Project
Sector	Water Supply and Sanitation
Type of project	Water Leak Management – Performance Contracting
City and country	Emfuleni, South Africa
City population	420,000
Initial Investment	US$ 800,000
Annual energy reduction	14 million kWh plus Water Savings of 8 million kL
Project status	Complete (January 2005-September 2005)

Project Summary

The water supply project in South Africa's Emfuleni Municipality resulted in lower costs for water--including lower energy costs associated with water supply--and also improvements in the municipality's financial status through a new leakage management system for bulk water supply. Innovative pressure management technology was applied to the water supply system of two low-income residential areas, yielding significant savings in water and energy costs for pumping and treating water for distribution. The payback period was only 3 months and financial savings, from both reduced energy use and water losses, was estimated at US$3.8 million per year for a lifetime of 20 years. Under the performance contracting arrangement employed to finance and implement the project, the municipality retains 80% of the water and energy cost savings during the first five years and 100% of the savings thereafter.

The project has been hailed as a great success for South Africa. It clearly demonstrates that the use of suitable technology under a shared savings arrangement can succeed in low-income communities. A private firm providing financing for technical innovation--at no cost to the municipality--received remuneration from sharing savings in water purchases. The contractor provided a basket of services, including financing of upfront investment capital, design, implementation, commissioning, operations and maintenance (O&M) over the contract period, as well as training municipal staff in operations prior to handover of the installation. The project resulted in substantial financial savings that led to a "win-win" situation, both for the municipality and contractor, through a successful public private partnership (PPP).

1. Introduction

The project is located in the low-income communities of Sebokeng and Evaton in the Emfuleni Local Municipality in the Gauteng region of South Africa, 50 km south of the metropolitan area of Johannesburg. These communities have a total population of

420,000, residing in 84,000 household units. The population growth rate is 2.7%, higher than the national average. The unemployment rate (51.5%) is also higher than the national average (27.8%).

The communities are supplied with potable water from a concrete reservoir through two large water mains (1000 mm and 675 mm diameter, respectively), running parallel to each other before splitting into two distinct areas. Metsi-a-Lekoa (Pty) Ltd., the water utility in Emfuleni municipality, serves Sebokeng and Evaton communities by purchasing water from Rand Water[1]. Despite the low socioeconomic profile, households have on-site water and waterborne sanitation, reflecting a high level of service. In 2004, the growing purchase of water by the utility and high water bills raised concern for Rand Water.

Rand Water initiated an emergency leak detection procedure by installing a data logger on the bulk water supply line to Sebokong and Evaton residential areas. It showed the Minimum Night Flow (MNF) reading was 2,800 m^3/hour in Sebokeng and Evaton, enough to fill two Olympic sized swimming pools every hour.[2] In terms of Non Revenue Water (NRW), 80% of water supplied was lost through leaking household plumbing fixtures, and this water entered the wastewater system, resulting in the outflow of raw sewage into the Vaal River, raising environmental concerns.

This assessment also identified relatively high pressure in the water distribution network, relative to demand needs, particularly in non-peak hours. As a result, many on-property pumping fixtures failed prematurely, further raising levels of leakage and water waste. Due to socio-political and economic factors, the leakage issue was not expected to be resolved for a long time as most fixtures would remain in a state of disrepair while high water pressure in the system continued to exacerbate damaged pipes and fixtures.

Emfuleni Municipality was aware of the tremendous opportunity to save water and the added benefits from energy savings in the water supply distribution systems of the two communities. However, the Municipality needed to select a suitable technology to maximize savings and provide for project funding.

It is theoretically possible to waste less water by repairing leaks on properties, but it makes more technical and economic sense to first reduce higher operating pressure to prevent further damage to existing fixtures and potential damage to repaired and/or replaced plumbing equipment. This can be done through advanced pressure management, which reduces and controls high pressure and allows it to be reduced further at night when full pressure is unnecessary due to low demand. Lower pressure in the system substantially reduces water leakage, providing water and related water bill savings. It also leads to less energy needed for pumping, providing significant energy cost savings.

[1] Rand Water is the largest bulk water utility in Africa and provides potable water to more than 11 million people in Gauteng, parts of Mpumalanga, the Free State and North West – an area that stretches over 18,000 sq. km. Rand Water purifies the water and supplies it to Municipalities, mines and industries. The municipalities in turn, supply the water to consumers.

[2] The Minimum Night Flow (MNF) measure was considered the most reliable measure of the volume of water supplied per hour to the network when there is little demand, generally between 1 a.m. to 4 a.m.

2. Project Description and Design

The water leak management project was promoted by the Alliance to Save Energy (ASE). ASE had credibility with the Emfuleni Municipality given its experience in South Africa promoting water and energy efficiency (under the "Watergy" program[3]) elsewhere in the country. ASE explained to Metsi-a-Lekoa how the project could maximize energy and water savings in the water distribution system, and proposed various measures. The utility in turn, in partnership with ASE, implemented the technical solution to reduce water leakage through pressure management.

Prior to project design, an analysis of flow-and-pressure logging data was conducted to predict how pressure management could be applied to produce the savings. Although most leaked water in the project area was lost through leaking fixtures, it made little sense to repair the fixtures without first lowering the water supply network's operating pressure that contributed significantly to the leakage, and increased the flow of raw sewage into the river. Many problems were also identified due to O&M of the distribution system. Program managers pointed out that solving these problems would require re-training many local system operators and would take considerable time and resources. ASE concluded that the best technical solution was installing an advanced pressure management system at the intersection of the two large water mains. The technology was expected to result in substantial water and energy savings, and equally importantly, save money.

All water distribution systems experience significant fluctuations in demand throughout the day, with morning and evening peaks coupled with periods of low demand at night, and sometimes during early afternoon. Since water supply systems are designed to provide minimum pressure throughout the day, they are generally designed to meet this pressure requirement during peak demand when friction losses are at their highest and inlet pressures at their lowest. Because of this design methodology, many systems experience higher pressure than necessary during non-peak periods. Major pipe bursts, for instance, tend to occur during the late evening and early morning when pressure is highest. The volume of water lost through a hole or leak also tends to increase at night. By controlling pressure during off-peak periods, it is often possible to significantly reduce losses without identifying or repairing leaks. With advanced pressure management technology, water pressure is reduced to the lowest acceptable level at night. (See Figure 1.)

As a trusted third party, ASE helped procure contracting engineering services for Metsi-a-Leoka. It drafted tender documents, which required bidders to secure financing for investment in the project. In addition, it provided assistance in legal arrangements, negotiations, and the statistical determination of future water supply projections (the baseline). ASE also served as an independent technical auditor to verify monthly savings and payments to the contractor.

[3] Alliance to Save Energy, Watergy Case Study, Emfuleni Municipality, South Africa, May 2006. See www.watergy.org for more information.

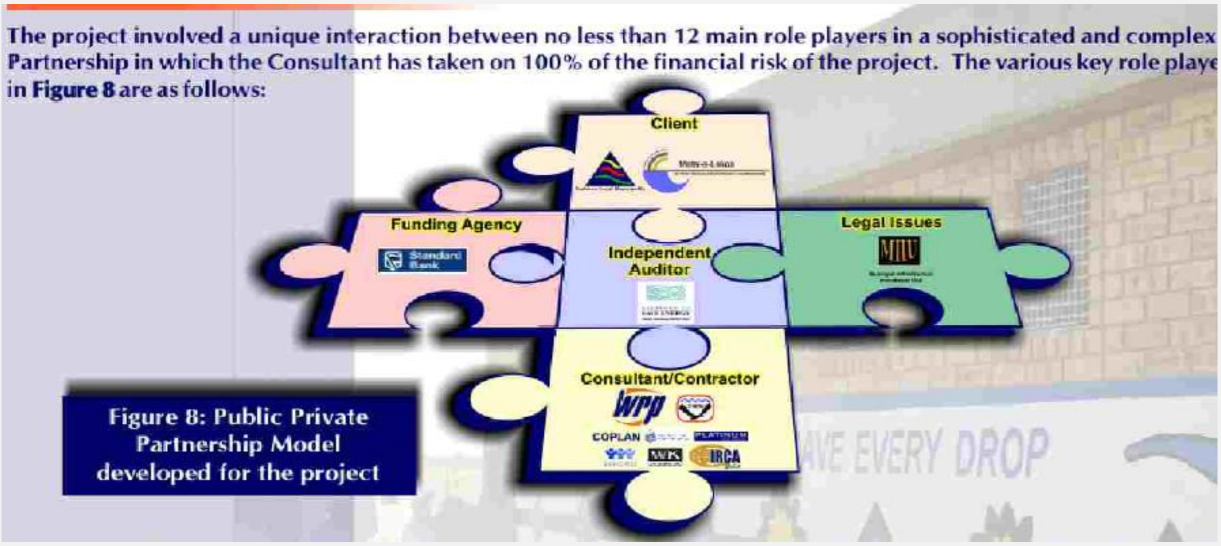
Figure 1: The difference in water losses when water pressure is reduced.

A consortium led by WRP Engineering Consulting Company was selected as the contractor under a competitive bidding process. Metsi-a-Leoka signed a water and energy performance contract under a Build-Own-Operate-Transfer (BOOT) arrangement for a period of five years. WRP acted as an energy service company, or ESCO, by providing turn-key services while undertaking all financial and performance risks. This contracting arrangement was deemed the best approach given Metsi-a-Leoka's and Emfuleni's limited ability to access capital, and their lack of technical capacity regarding advanced pressure management technology. WRP was required to provide a basket of services, including financing, design, implementation, commissioning, and O&M over the contract period, as well as training municipal staff in operations prior to the transfer of equipment.

The contractor constructed a pressure reduction plant just before the split of the two large water mains/pipes servicing Sebokeng and Evaton. Advanced pressure management consists of time-and-flow related pressure control valves in a single, large, above-and-below ground chamber, together with other accessory plant and equipment. (A pressure control valve is essentially a modulating valve--continuously opening and closing--that throttles the flow of water passing through it, to a degree dependent on downstream pressure in the water network.) Downstream pressure (via the control valve) is controlled via an electronic controller, allowing water pressure to vary according to time of use over a 24-hour period. The electronic controller has up to 10 settings per hour, allowing network water pressure to be reduced.

The project involved a sophisticated and complex PPP involving at least 12 stakeholders: WRP took the lead for project implementation and project performance risk; Metsi-a-Lekoa, a water utility formed by Emfuleni Local Municipality, was the client; WRP received financing from The Standard Bank of South Africa; facilitation of the project contract was done by the Municipal Infrastructure Investment Unit (MIIU); and, ASE undertook auditing/monitoring and verification of savings. WRP's team included specialist support from DMM, Platinum Consultants, and Coplan. In addition, Wide Bay Water in Australia provided support as a specialist reviewer. Other team members included IRCA, Batho Pele, and WK Construction. (See Figure 2.)

Figure 2. Project Partnership Arrangements



3. Cost, Financing, Benefits, and Effects

Cost and Financing

Under the BOOT-type performance contract, WRP was required to provide engineering designs and construction of the bulk water pressure management system, as well as full project financing. WRP invested about US$800,000 under a "Shared Savings Agreement." Under this arrangement, WRP received remuneration for its services based on verified energy and water savings from the project over a 5-year period. Twenty percent of the project's savings were to be accrued by WRP Consulting and 80% were retained by Metsi-a-Lekoa.

Benefits

The project's success has been documented as "roaring." The project--the world's largest single pressure management installation--has yielded financial savings to the municipality exceeding initial expectations. Water savings are 7-8 million m^3 per year, representing a total of 30% of the former supply of water saved. Daily water savings assessed were equal to 19 million liters (M*l*) per day. The project also resulted in substantial energy savings from pumping due to reduced pressure and water flow. The annual savings amounted to 14,250 MWh of electricity produced with fossil fuels, especially low-grade coal. Metsi-a-Lekoa saw a reduced carbon footprint in its water business operation, leading to a greenhouse gas (GHG) emission reduction of 12,000 metric tons per year. In terms of financial savings, total cost savings were US$3.8 million per year, with a payback period on the initial investment of less than 3 months. The advanced pressure management technology has thus been very cost effective in this application.

WRP recovered the capital cost of its investment in one year; the total return to WRP represents 4 times its initial investment. Since the installed infrastructure has a design life of 20 years, the Emfuleni Municipality is expected to accrue 80% of total project benefits (US$3.8 million) during the 5-year performance contract period, and the entire $3.8 million annually thereafter for the next 15 years.

The project also produced system benefits for the utility. Previously, all Metsi-a-Lekoa revenue was used to support the water account from Rand Water. Now, the Municipality has surplus funds to provide for maintenance of its systems. The project has also supported restoration of sewage plants to working order.

Households had previously played a significant role in contributing to water leakage. The technology employed during the project reduced water leakage, in turn significantly reducing sewage flow into the Vaal River. Raw sewage spillage had threatened the viability of the reserve water resources of Gauteng Province. Reduced pollution in the Vaal River has also promoted the potential of tourism, offering an economic lifeline for the area. Positive exposure from the project has created a general atmosphere of success within the Municipality and among municipal managers, who have since been invited for interviews by the general media to discuss the project. Communities located downstream also have been spared from substantial water treatment costs on account of Emfuleni's reduced sewage ouput. Finally, WRP consulting hired local labor, improving the Municipality's employment situation.

Spillover effects

The huge publicity garnered by the project spurred several governments and semi-governmental organizations to offer support to Emfuleni residents. It has created awareness at the highest level of government, with acknowledgment by the Parliament. The Department of Water Affairs and Forestry (DWAF), the national custodian of water, has shown its commitment to similar projects in the country by addressing constraints to financing.

4. Project Innovation

When the Government failed to arrange for financing for the Sebokeng/Evaton project, the chief executive officer of WRP took the initiative to underwrite the project himself, by remortgaging his own house to finance the project cost: He was convinced it would be a successful and profitable enterprise. The risk paid off and, within three months, he was able to show significant savings from the project.

The project's success has also demonstrated that the PPP model can succeed on a relatively small scale, contrary to the general view that this type of project is only viable for large-scale initiatives, due to the generally high transaction costs. The project's approach to performance contracting, using the shared savings model, also represents a breakthrough innovation in performance contracting in the water sector in South Africa, being the first of its kind in all of Sub-Saharan Africa.

5. Lessons Learned

The project benefited greatly from the presence of committed local partners such as ASE and WRP, who were aware of South Africa's issues in the water and sanitation sector. They were viewed as competent and credible entities with substantial experience dealing with energy efficient technologies. The commitment of the CEO, who took responsibility for financing and stood behind the project performance, cannot be downplayed. These were the two most important factors allowing for the PPP arrangement.

The project demonstrates that selection of a technology suitable for local conditions is important to maximize energy and water savings. This translates into a potentially attractive arrangement for an operation like BOOT, providing high returns to the private sector and also strengthening local public institutions, by transferring skills needed to design and negotiate project contracts. This also helps to develop abilities needed to address O&M technical issues in water distribution system.

As for the technology's success, it is clear that advance pressure management works best where there is high pressure and a major waste of water. It is suitable for a bulk water supply system supplied from a high-to-low point. The fewer the supply points (in this case, two), the less complicated the intervention and the more cost effective the solution.

6. Financial Sustainability, Transferability, and Scalability

The project has significantly improved the financial situation of Emfuleni. The Municipality will derive some US$72.2 million in benefits over the 20-year project life without having to incur upfront investment costs or take on additional debt. The ability of the system to sustain current savings will depend on how system improvements are managed and maintained over time. The training imparted to local staff by WRP, as required under the contract, will yield results at the expiration of the contract in 2010. Assuming the project's local champions and those who receive training stay in the system, it is likely financial savings will be sustained.

Following the project's success, Metsi-a-Lekoa and ASE are looking at the potential to further deploy water pressure management by dividing the water network area in smaller supply zones, so each area has its own advanced pressure management system. However, more financing sources will be needed to ensure the project can be replicated elsewhere.

With the national government intervening, the project is spurring water demand management activities, such as consumer metering & billing; a debt collection system; community awareness, with particular reference to garden watering; additional savings from pressure management for low-lying communities; and continuous monitoring of control points to assist with system management. If such practices continue, the financial health of Emfuleni will be sustained.

References

1. Alliance to Save Energy, Water Case Study, Emfuleni Municipality, South Africa, May 2006.
2. Ronnie McKenzie, Implementation of Pressure Management in Municipal Water Supply Systems, presentation at EYDAP Conference on "Water: The Day After," Athens, March 20, 2009.
3. Mike Muller, South Africa: Tragedy That Flows Through the Triumph at Vaal River, Business Day, April 23, 2008.

4. C40 Cities Climate Leadership Group, Best Practices - Water: Emfuleni, South Africa, Clinton Climate Initiative, http://www.c40cities.org/bestpractices/water/emfuleni_efficiency.jsp
5. R. McKenzie and W. Wegelin, Sebokeng/Evaton Pressure/Leakage Reduction: Public-Private Partnership, Conference Proceedings, Leakage 2005.
6. Mike Rabe (Alliance to Save Energy), Personal communication, 2008.

ANNEX: CITY AND PROJECT PROFILE

CITY PROFILE

1. Name of the City	**Emfuleni Municipality**
2. Area	**South Africa**
3. Population	**1.2 million**
4. Population Growth Rate	**2.68%**
5. GDP of the City	**N/A**
6. GDP Growth Rate	**N/A**
7. GDP per Capita	**N/A**

PROJECT PROFILE

1. Project Title	**Sebokeng/Evaton Pressure Management Project**
2. Sector	**Water Supply and Sanitation**
3. Project Type	**Water Leak Management**
4. Total Project Capital Cost	**US$ 0.8 million**
5. Energy/Cost Savings	**$3.8 million/year**
6. Internal Rate of Return	**Payback period of 3 months**
7. Project Start Date	**July 2005**
8. Project End Date	**September 2005**
9. % of Project Completed	**Completed**

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