Atlantis, South Africa

Recycling wastewater to bolster ground water supply: the Atlantis Story

Following legislative changes in the mid-1970s, Atlantis was obliged to find an alternative to marine wastewater discharge. In 1979 it began recharging its storm water and treated wastewater into its sandy soils. Located in a semi-arid region with few surface water resources and a rapidly growing population, it further became apparent that longer term needs of the town could not be met by the natural groundwater yield of the aquifer. The focus then shifted to recharging the aquifer and recycling water, supported further by the later separation of domestic and industrial effluent in order to ensure recharge of the highest quality water. Such has been the success of these cost-effective artificial recharge solutions, in operation now for nearly 30 years, that they are being replicated elsewhere within southern Africa where water resources are scarce, most especially for towns that are heavily or solely reliant on ground water.

Population: 76,000

Land area: 31.1 km2

For over three decades the town of Atlantis, situated in the Western Cape of South Africa used only groundwater for its residential and industrial water needs. This was achieved by recycling water through the utilisation of stormwater and treated domestic effluent to recharge the groundwater aquifer. The Atlantis Water Resource Management Scheme (AWRMS) successfully recharges 30% of the Atlantis groundwater supply. Initially the indirect recycling of treated wastewater and urban stormwater runoff was considered primarily from the perspective of an economic means of wastewater disposal. However, water conservation soon became a key benefit of the scheme in this water scarce region. Various combinations of urban stormwater and treated wastewater from the town are now infiltrated into the aquifer to maximise the available groundwater. A major contributor to the success of the scheme has been the separation of source water into different fractions to allow for recharge of the highest quality water to the most critical areas. In addition, several refinements have been made to the artificial recharge system to ensure that any potential deterioration of water quality would not jeopardise the scheme. In this way the AWRMS pioneered the application of artificial groundwater recharge with stormwater and treated wastewater as a cost-effective water management tool for bulk water supply.

The importance of the issue

Growth and development of human settlements require access to potable water and suitable systems to dispose of wastewater; a key municipal challenge with exponential population growth, rapid urbanisation and industrialisation. As such, cities are continuously exploring innovative solutions to augment water supply within their boundaries. In urban areas that rely solely or heavily on a limited water source, the recharge of existing aquifers with treated wastewater has proved to be a highly successful method of increasing existing reserves. Such systems offer multiple benefits: they often require lower capital investment, they reduce or eliminate wastewater discharge, they decrease treatment costs and contribute to in-situ water conservation. The objective of the Atlantis Water Resource Management Scheme (AWRMS) was to augment the existing water supply to the town in order to meet the increasing demand. To date 30% of the groundwater in Atlantis is augmented by artificial recharge with treated wastewater.

Part financed by the European Commission and running from December 2009 to November 2012, ACCESSanitation is working directly with cities in India and the Philippines to tackle inadequate urban sanitation. In addition, the project is also promoting sustainable sanitation on a larger scale through the transfer of good practice elsewhere in the target countries as well as from and to cities in Sub-Saharan Africa. ACCESSanitation is coordinated by the ICLEI European Secretariat located in Freiburg, Germany.

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Local context

Atlantis is located 50 km north of the City of Cape Town along the semi-arid west coast of South Africa. With a population of over 76,000 people, Atlantis lies within the Cape Town metropolitan area. Designed in 1976 under the government's "decentralisation initiative' as an industrial town and a National Growth Point (titled 'Wesfleur') ,it served to reduce pressure on the nearby Elsies River town, which was experiencing considerable pressure on service delivery as a result of exponential growth. Subsequent rapid growth of Atlantis resulted in unplanned pressure on the infrastructure and services, which coupled with a government decision to rethink its strategy of subsidisation of industries, resulted in growing unemployment and poverty as livelihood opportunities shrunk. Furthermore, poor transport links between Atlantis and Cape Town, have made it unattractive to residents not employed in the immediate vicinity. However, it is still one of the largest towns in the Western Cape and as development in the region expands, it is predicted that Atlantis is likely to be rejuvenated and re-developed.

Atlantis experiences a Mediterranean climate with most of the 450mm mean annual rainfall occurring between April and September. Up to 30% of this annual rainfall drains into the aquifers/groundwater system, particularly through the un-vegetated dune areas. While Atlantis has always been dependent upon groundwater, growth and an increasing population has exerted increased pressure on resources resulting in the development of the Atlantis Water Resource Management Scheme (AWRMS).

Reusing water: Pioneering underground storage of treated wastewater to increase local ground water supplies

When Atlantis was first established, water supply was provided from a single borehole, then later from perennial springs at Silwerstroom. It was soon recognised that the existing water resources would not be sufficient to support the population and growing industry within the area. The closest feasible water source was the Berg River located 70km away, where a dam was commissioned to accommodate the water demand from Atlantis. In the interim however, research undertaken to examine the groundwater resources identified bountiful aquifers, recharged by rainfall. Consequently, the Silwerstroom and Witzand well-fields were developed and the Berg River plan never materialised. These well-fields provided water to the settlement for over three decades and only in 2000, was supplementary surface water added to the system.

Until the 1970s marine discharge of treated wastewater was common practice in South Africa. However public resistance increased and the Department of Water and Forestry could no longer condone the unregulated discharge of wastewater. This resulted in a change of legislation to include a strict permitting system for wastewater discharge, with a stringent monitoring protocol. However, the costs associated with adhering to the new wastewater discharge permitting system and protocols became prohibitive and resulted in pilot studies to investigate alternative applications of wastewater, such as the potential of recharging aquifers with treated wastewater in the Cape Flats (1973-1979). The results of the pilot studies provided Atlantis an attractive alternative for dealing with wastewater.

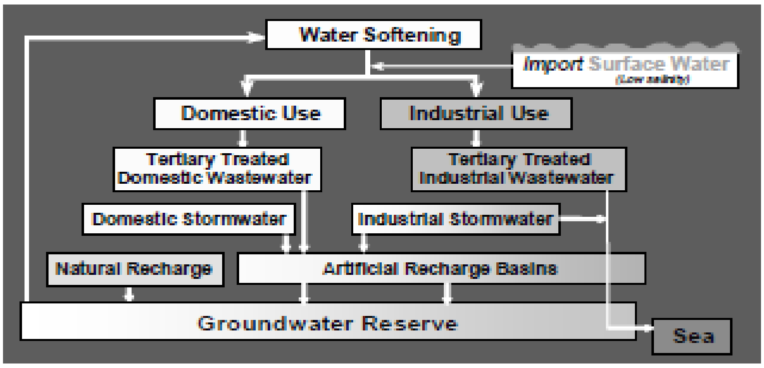
Atlantis began recharging its stormwater and treated wastewater into its sandy soils in 1979. Over time the system developed to integrate water supply, wastewater, and stormwater systems from over 40 different projects. The overall scheme is referred to as the Atlantis Water Resource Management Scheme (AWRMS). Throughout these developments the non-negotiable target was that the quality of water to be recharged should be equal to, or exceed, the quality of the existing groundwater.

Residential and industrial effluent (jointly treated in the mid 1970's in a combined wastewater treatment works) was directed from maturation ponds to detention ponds for infiltration into the sand. In 1979 urban stormwater runoff was added into the recharge system.

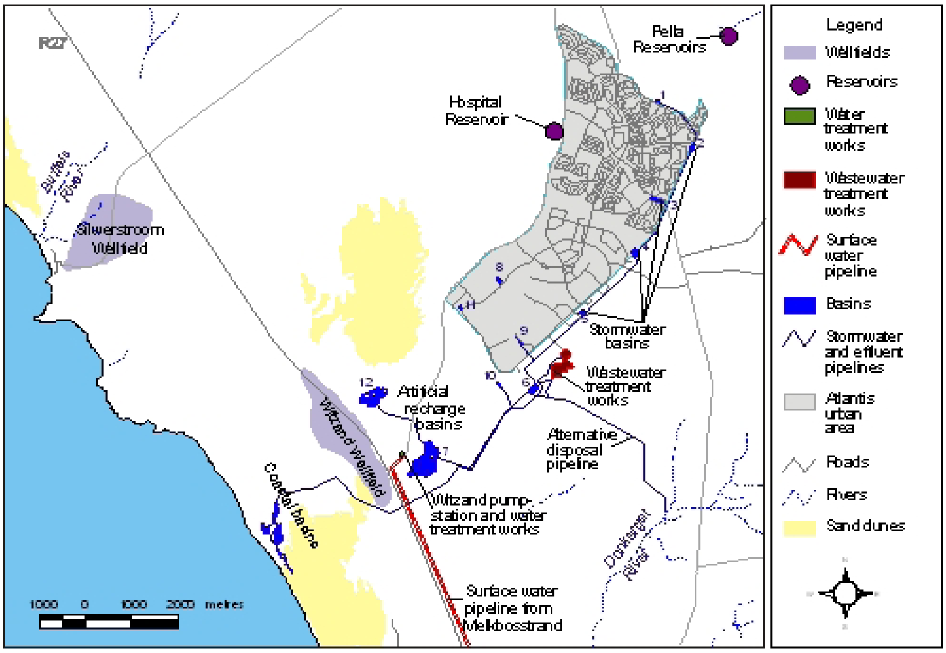
The industrial wastewater was significantly affected by various industries, particularly the textile industries, which had set up their own water softening works using ion-exchange resin, with salt as a regenerator to soften the water. This degraded effluent significantly led to the separation of domestic and industrial wastewater and its separate treatment works. The industrial effluent was directed into coastal detention beds, creating a steeper hydraulic gradient, to reduce the outflow of good quality groundwater and reduce the risk of seawater intrusion into the aquifer. Similarly, the stormwater system was later adjusted to channel peak flow and base flow to different recharge basins to maintain good quality water in selected areas of the aquifer.

Currently, treated domestic effluent, all domestic stormwater, and most industrial stormwater is used for recharging the aquifer up-gradient of the well-fields in two infiltration basins, with industrial effluent and the remaining industrial stormwater being diverted to the coast. The system consists of twelve detention and retention basins and the necessary interconnecting pipelines with peak flow reduction features.

Since 1998 water from Cape Town has been imported to augment flows in Atlantis. This is an important emergency back-up for when bio-fouling and borehole maintenance issues lower the flows from the aquifers. A positive by-product of this good quality imported water is a decrease in overall salinity within the system, improving the quality of the water. It also minimises the need to soften the water abstracted from the Witzands Aquifer.



Atlantis Water Recharge Management Scheme schematic diagram (City of Cape Town)



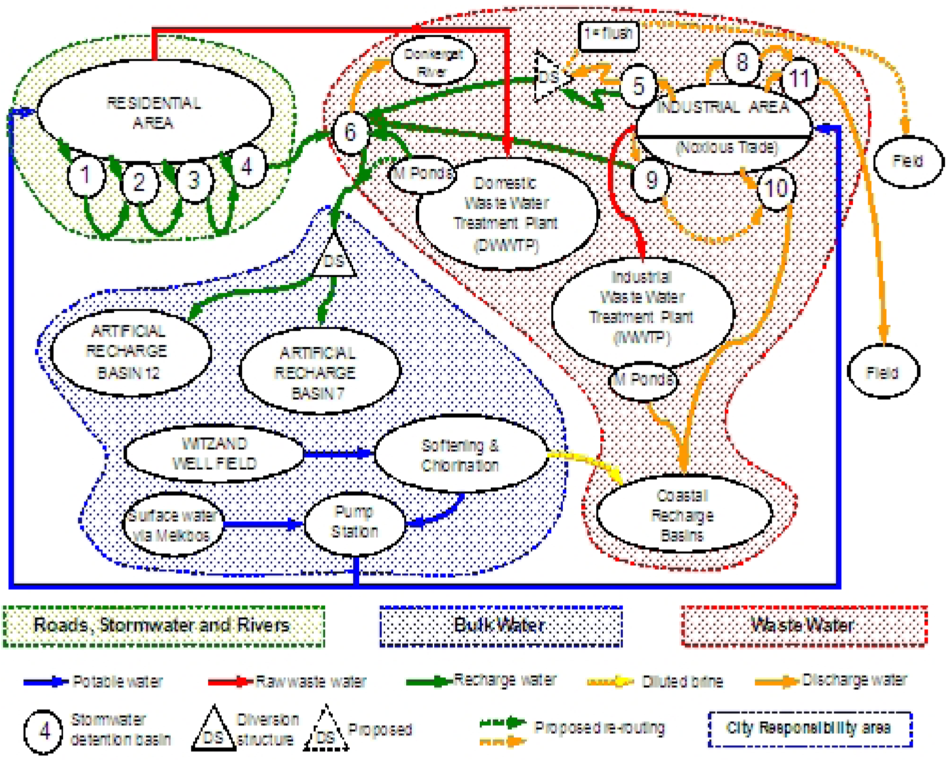
Atlantis Water Recharge Management Scheme layout (City of Cape Town)

Results

Following the introduction of the Atlantis Water Recharge Management Scheme (AWRMS) the inhabitants of Atlantis, which is located in a semi-arid region with few surface water resources, now have access to good quality potable drinking water. The integrated nature of the scheme and the local adaptation that has taken place, ensure the system is locally viable and acceptable. Consumer relations for the AWRMS were maintained through good communication with both industry and the community via quarterly meetings. Industries, however, were more active in engaging with the scheme management than the community, and have assisted in the continued development of the scheme. The textile industries' need for soft water led to the development of an ion-exchange water softening plant using sulphuric acid as a regenerator. The waste acid is blended with the industrial treated effluent and no further neutralisation is required.

Communication with the community was facilitated through the Atlantis Management Committee. While initially they experienced some complaints of 'hard' water causing domestic water heaters and kettles to build up deposits of calcium, this was soon rectified following the installation of hard water elements and the commissioning of the Witzands softening plant.

The AWRMS provides 48 jobs in the operation and maintenance of the system, further contributing to the local economy and community.



Overview of Witzand section of Atlantis Water Recharge Management Scheme (City of Cape Town)

Lessons learned

The Atlantis Water Resource Management Scheme (AWRMS) has proven itself as an innovative, highly successful, functioning scheme that has won various awards. The following factors need to be considered to ensure the system remains successful:

Administration: long-term sustainability of the complex large-scale AWRMS depends on proper maintenance of all components, requiring a multidisciplinary approach. Prior to July 1997, Atlantis was managed as an independent town, thus management of the key components of the scheme (water supply and quality, wastewater treatment and urban stormwater management) was locally concentrated, allowing for close control. Post 1997, Atlantis was incorporated within the Cape Town metropolitan area resulting in the redistribution of functions over several departments such as bulk water, wastewater, roads and stormwater, parks and forests. Coordination between these and other relevant structures is essential for AWRMS to function properly. In addition groundwater as a water supply source is a relatively new concept to the City of Cape Town, and "ownership" still needs to be embedded at all administrative levels.

Operation: basin clogging can occur due to the build-up of fine sediments and organic material on the bottom of recharge basins overtime. If not addressed such build-up results in decreased infiltration to the aquifers, limiting ground water recharge. If too much water is abstracted from the aquifer the water levels drop allowing air into the system. This disrupts the balance of the natural ecology at a borehole site, which can lead to bio-fouling and naturally occurring iron in the groundwater clogging the borehole intakes.

Uncontrolled abstraction threats: Uncontrolled groundwater abstraction in the area reduces the volumes of groundwater available for public supply and affects predictions of sustainable yield from the aquifer. The two forms of uncontrolled abstraction are: 1) small and medium scale users with private boreholes used mainly for irrigation; and 2) alien invasive plant species (Acacia cyclops and A. saligna) that are prevalent in the area and as water thirsty plants reduce water available for groundwater recharge.

Threat of saline water encroachment and increased groundwater salinity: High quality, low salinity water occurs in and around the high recharge area of the dunes and at the well-fields. These need to be bordered by waters of marginal quality where the aquifer thins out against the bedrock in order to combat the effect of saltwater intrusion.

Groundwater pollution threats: The Atlantis aquifer is unconfined and thus vulnerable to pollution from several sources. A bulk oil pipeline passes through the well-field and even a small leak from the pipeline could be disastrous. Hazardous chemical spills may occur in the industrial area, which may affect the aquifer directly at the site of the spill or via the stormwater system. Point sources of pollution include the wastewater treatment works, the cemetery to the north of the town and the old, unlined municipal waste disposal site. Non-point sources of pollution include the agricultural practices of small scale farmers and development of un-serviced informal settlements.

Replication

The successful reuse of stormwater & treated domestic wastewater at Atlantis was a pioneering innovation that restructured thinking in regard to stormwater and wastewater systems in the Western Cape. It led to the adoption of 'natural groundwater recharge', within the City of Cape Town draft by-laws, in respect to stormwater management. More recently other towns and large metropolitans in South Africa including Gauteng and Durban have explored the application of stormwater and wastewater systems' contribution to maximising the sustainable use of the available water supply.

Several other recharge operations in southern Africa emerged, alongside the Atlantis Water Resource Management Scheme (AWRMS), and continue to build upon the experience gained at Atlantis, with the lessons and innovative practices emerging from Atlantis contributing to the development of the Departments of Water Affairs and Forestry "National Artificial Recharge Strategy" in 2007.

The pioneering research developed will benefit both large towns that have extensive infrastructure and skilled staff) and also rural communities that have minimal infrastructure and human resources.

Budget and finances

Early financing for capital works and construction was relatively accessible. However, operational finance has decreased resulting in increased difficulty in funding further works. This has a corresponding negative impact on Atlantis and can hamper the upgrading of the system. The cost of running the system is economically efficient compared to the alternatives i.e. transporting surface water 70km from the Berg River or desalinisation. It also safely deals with wastewater. Furthermore if abstraction from the system is managed to ensure that air does not infiltrate it negates the costs of de-clogging boreholes, which currently costs approximately US$ 7,500 per borehole.

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