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# ARTIFICAL RECHARGE IS A GENUINE SOLUTION

## *Storing water in the rocks is the answer to some big water supply questions. By Mike Wills*

They gamble on everything in Las Vegas except the water supply.

To ensure that the booming city never runs dry, water engineers in Nevada have established one of the world's biggest and most successful artificial recharge, storage and recovery schemes, pumping treated water underground into natural aquifers and then extracting 0.59Mm³ per day when needed.

Artificial recharge (known as AR) is an important weapon in effective supply management in water-poor regions around the world. It is widely used in the USA, Australia and Europe, has attracted R33bn in investment from the Indian government and been enthusiastically pursued by the Namibians, but it has been under-utilised in South Africa. The Department of Water Affairs & Forestry (DWAF) is now trying to change that. They have developed a strategy and a legislative framework that will enable local water authorities to make wider use of the natural storage capacity that lies in the rocks and thereby provide a sustainable opportunity to conserve water and improve its quality.

AR takes many forms but, in its most basic applications, it involves transferring surface water underground into suitable natural aquifers, either via borehole injection or sand infiltration ponds, and then extracting it on demand. In some instances groundwater storage can be used instead of expensive and environmentally disruptive dams or lengthy pipelines from distant sources, in others it can be used as an adjunct to surface water storage and become a 'water bank' to meet seasonal demands or in response to the strains of a drought.

AR can work on almost any scale. In Southern Africa two recent successful applications have been in the city of Windhoek and the tiny, isolated Namaqualand community of Karkams. Dr Peter Dillon of Australia's widely respected CSIRO says "the success of both those sites cannot be overstated, potential for reversing declines in groundwater storages, expansion in water supplies, and in increasing security of supply are clearly evident, and the technology has been decisively proven effective".

The Windhoek case study is especially impressive. Needing to raise their supply capacity from 21*Mm³/a* to more than 30 *Mm/³a* by 2019 and to improve their security in drought years, local authorities were faced with the prospect of spending R1.7bn on a pipeline from the Kavango River to supplement their current supplies that depend heavily on three existing dams. Instead they opted to expand their existing groundwater extraction scheme and make better use of the aquifer in the surrounding mountains to store water that would otherwise be lost to evaporation from their dams, or lost as overflow during high rainfall years. The aim is to increase groundwater yield potential from 1.7 *Mm³/a* to an estimated 19 *Mm³* (although such a high level of extraction would not be feasible every year, it would be possible in an occasional drought year).

Windhoek's quartzite aquifer is highly fractured and complex but extensive pilot testing established the viability of rapid replenishment and large scale abstraction.

The capital cost of the artificial recharge scheme at R242m was one-seventh of the pipeline and could be spread across four phases as compared to the massive up-front capital outlay demanded by the pipeline. And AR scored considerably better by any measure of environmental impact and global warming concerns. Further benefits were the ability to rectify a worrying drop in groundwater levels in the old wellfield areas and engineers being able operate the existing dams at higher risk levels.

Ten new deep boreholes have been drilled and initial injection and abstraction results far exceed expectations. The engineers involved in the project emphasise the absolute priority of siting the boreholes correctly. Dr Ricky Murray of Groundwater Africa, who is responsible for designing the artificial recharge scheme says "the ten new injection sites are achieving the same level of inflows as fifty of the existing, older boreholes partly due to improved technology but largely due to their pinpoint location".

Not all geological formations are suitable for groundwater storage due, among other things, to poor hydraulic conductivity and the quality and compatibility of the source water and the natural groundwater supply, but a survey of aquifer storage potential in SA, conducted for DWAF, shows vast untapped potential both in primary aquifers suitable for infiltration, and fractured and weathered aquifers that would involve borehole injection. The Limpopo, Crocodile West Marico, Lower Vaal and Lower Orange Water Management Areas show the highest potential AR storage volumes but small scale opportunities exist virtually everywhere in the country.

Even assuming that the hydro-geological conditions are suitable and the safe and sustainable yield can be increased, AR does have some pitfalls which can be avoided with proper research and scheme management. The main ones are:

- the water mix must be correct – the surface water being introduced must be of a superior quality to the existing groundwater and the chemical reactions between them must not be negative
- clogging problems affect as many as 80% of AR sites worldwide but in almost all instances effective monitoring of flows and early remedial measures will prevent disruptions.
- artificially raised groundwater levels can cause die-back, subsidence, flooding or increased salinity
- artificially lowered groundwater levels can affect rivers, wetlands and trees.

Plettenberg Bay is one town that is actively exploring AR at the moment - faced with winter rainfall and a high summer demand, the storing of Keurbooms River water underground in the local aquifer is likely to be cheaper and more effective than building a desalination plant or constructing an off-channel storage dam – but other local water authorities need to be learning the lessons from the Namibians, who have also successfully used AR to supply Swakopmund and Walvis Bay from the ephemeral Omaruru river.

While no one at DWAF is suggesting that artificial recharge can be a complete solution to every problem, the department is of the view that every water engineer in the country needs to understand its potential as a weapon in the constant battle to conserve water and for sustainable supply.

***DWAF's Artificial Recharge Strategy*** *is available for downloading from their website (http://www.dwaf.gov.za). Go to "Documents" and two-thirds down the long list of DWAF documents, you'll find the strategy under "Other: Integrated water resource planning – National Documents".*