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BANKING WATER

Artificial recharge is a key tool in water storage. By Dr Ricky Murray.

Every consulting engineer and municipal official involved in water supply in Southern Africa should be aware of the potential benefits of artificial recharge – a system of conserving and storing water underground where it isn't vulnerable to evaporation losses or contamination.

Many of our local geological formations contain appropriate aquifers that could be used to enhance the water supply at a far cheaper and more efficient rate than dams. In some instances the capital costs of using aquifers for water storage amount to less than half those incurred in more conventional surface storage schemes and artificial recharge offers considerable benefits in terms of any quantifiable costs of climate change.

Artificial recharge has been widely implemented throughout the world - about 15% of Germany's drinking water is produced through artificial recharge; in Florida, USA, one scheme has 21 injection boreholes with a combined capacity of 68 000 m^3/day; in India, the government plans to spend R 3.3 billion per year over the next ten years on such schemes – but, to date, it has only been applied on a limited scale in our region.

The Department of Water Affairs (DWAF) is determined to rectify this situation and has recently approved a strategy that's designed to encourage municipalities to explore this option and also to provide a regulatory framework for implementation. The strategy is being administered by DWAF's Directorate: Water Resource Planning Systems.

In most instances, artificial recharge involves transferring river or dam water underground by means of infiltration basins or by borehole injection. The water is then stored in the subsurface for later use. The water usually needs to be treated beforehand to prevent clogging of the surface of the basins or the boreholes although in many European countries the process itself is used for water treatment purposes with the sandy aquifers serving as giant natural filters.

There are several determining factors in the potential for artificial recharge. The key ones are that the water needs to be of a consistently high quality with low turbidity and must be compatible with the existing groundwater; the aquifer geochemistry must not produce health concerns and the aquifer's hydraulics must allow for the recharged water to enter the aquifer rapidly and be contained within it. A relatively straightforward geological and hydrogeological survey can produce a flow model which will establish whether these criteria can be met.

The technique is especially effective in areas vulnerable to seasonally distorted rainfall and consumption patterns. Plettenburg Bay is a classic case. The town has sky-rocketing consumption patterns over the summer festive season. Rather than desalination or building an off-channel storage dam using water from the Keurbooms River the municipality is exploring the far cheaper possibility of storing Keurbooms River water underground in the local aquifer. Borehole injection tests are planned for later in the year and if the results are positive and they are able to bank their surplus winter water underground where it will not suffer from any evaporation loss and then pump it back into the domestic supply during summer, the potential savings for the local ratepayers will be immense and the security of the water supply will be enormously enhanced.

In addition artificial recharge schemes can help in optimally managing the aquifer in ways that include restoration of groundwater levels which in many areas have been dangerously lowered by constant borehole use, reduction of land subsidence, prevention of saltwater intrusion and enhancement of wellfield production.

The obvious environmental benefits are minimal land use and a considerably reduced environmental imprint when compared to a dam but they also include reducing abstraction from rivers, maintaining groundwater levels and in-stream flow requirements and the hydraulic control of contaminant plumes.

Artificial recharge is also currently being explored in Prince Albert and Langebaan but there are several significant, established success stories in the region on divergent scales.

In the small village of Karkams in Namaqualand a very low yielding granite and gneiss aquifer has been opportunistically recharged to double the annual output from the borehole with a higher quality of water. The scheme uses a sand filter that it is built into an ephemeral river and the only maintenance required is the weekly removal of the fine sediment that can slow down infiltration.

Atlantis, just outside Cape Town, has been getting around 40% of its water from an artificial recharge scheme for over twenty years. Using the thin coastal aquifer of unconsolidated sand dunes, low salinity storm runoff and high quality treated domestic wastewater are channelled into two large spreading basins for artificial recharge at a point higher than the main wellfield, while treated industrial wastewater and high salinity baseflow are diverted to the coastal recharge basins to create an hydraulic mound which prevents the seawater from intruding into the wellfield. The scheme demands careful management to avoid iron related clogging problems which can lead to a decline in yield and some water has had to be imported from outside the catchment area to improve quality but overall artificial recharge has ensured the sustainability of Atlantis's water supply.

On a far bigger, scale the Namibian capital Windhoek opted for artificial recharge from its surrounding mountainous aquifer rather than a surface water transfer scheme from the Okavango River because it is R1.3 billion rand cheaper. An additional ten injection/abstraction boreholes are currently being added to the existing five and the target capacity is 8 Mm^3/annum or ~250 L/s of continuous injection. The aim in Windhoek is to be able to get water underground as rapidly as possible before it evaporates from one of its shallow dams. Windhoek's aquifer of quartzites and schists is highly fractured and complex but extensive testing has established the viability of rapid replenishment and large scale abstraction.

Artificial recharge systems can range from the very simple to the highly sophisticated but they all present management challenges. Quality of water is critical, as is the prevention and managing of clogging at injection points. The constant monitoring of the effects of artificial recharge is also vital. There are specific geological and environmental factors that determine what is a safe yield from any specific groundwater source - as just one example, over-abstraction from a dolomitic aquifer can easily produce sink holes - but there is a wide range of readily available international experience that can be analysed for local benefit alongside a growing pool of southern African case studies.

The security and quality of water supply is a key issue facing every municipality and the conventional options are, to coin a phrase, running dry. The potential for major dam expansion is, in many areas, exhausted and the global trend is against such massively disruptive and expensive projects. The most logical solution may well be a geological one – using the nooks and crannies of the labyrinthine rock structures beneath our feet.

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".*

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