## 10.2 Small-scale borehole injection in Namaqualand

The village of Karkams, with a mean annual rainfall of 250 mm and a population of 1700, depends solely on groundwater.

Natural groundwater recharge is very low, and as a result of abstraction since the mid 1990's, groundwater levels have dropped tens of metres and the water quality (salinity) has deteriorated significantly. The aim of artificial recharge is to reverse this negative trend by rapidly replenishing the aquifer when river runoff is available.

*Karkams village*

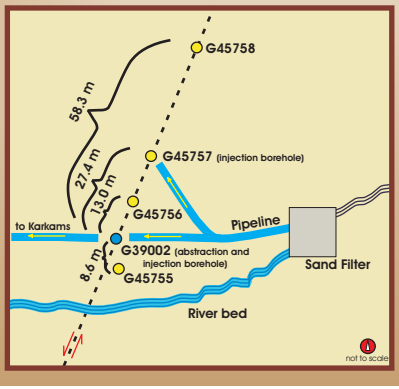
### 10.2.1 The hydrogeological setting

The Karkams aquifer consists of granites and gneisses cut by major faults on which high yielding boreholes are sited. The groundwater quality is characterized by relatively high salinities (~250 mS/m), and high fluoride (~ 3 mg/L). The water quality changes from relatively fresh water near the surface to older, more stagnant water at depth.

*Pump house for the injection and abstraction borehole*

### 10.2.2 THE ARTIFICIAL RECHARGE SCHEME

The scheme consists of a sand filter that is built in the bed of an ephemeral river. Most of the water, when available, flows over and past the filter, but some infiltrates the sand filter and is gravitated to the injection boreholes. The only maintenance required during operation is weekly removal of the fine sediment that settles on the filter since it slows down infiltration.




*Layout of the artificial recharge scheme*

*Sieving river sand for the sand filter*

*Sand filter with the pump house in the background*

### 10.2.3 Borehole injection tests

Three controlled injection runs from 1999 to 2001 had the effect of reversing the declining water level trends. During the longest test, which lasted for 138 days, 6 567 $m^3$ was injected. This is more than twice the annual sustainable yield of the borehole (2 400 $m^3/a$).

The water quality improved significantly after injecting the clear, filtered river water. With three consecutive years of artificial recharge, the electrical conductivity values dropped from over 250 mS/m prior to injection to less than 100 mS/m after injection.

### 10.2.4 Conclusions at Karkams

This case study demonstrates the value of opportunistic artificial recharge, and that a very low yielding borehole and a low yielding aquifer can be recharged at relatively high rates. An additional benefit of introducing fresh water to the aquifer is that it significantly lowers the salinity of the groundwater.

During years with rainfall, this scheme provides good quality water to the residents of Karkams. This is water that would otherwise be lost to evaporation. The Karkams case study shows that this technology is not only applicable to large-scale schemes, but that it can be used effectively in small-scale operations. It also shows that the principle of conjunctive use is valuable in augmenting Southern Africa's rather limited natural recharge.

## 10.3 Atlantis: 20 years of artificial recharge using infiltration basins

*(adapted from G Tredoux, E C Murray & L C Cavé, 2002)*

The town of Atlantis, located 50 km north of Cape Town, has a population in excess of 100 000. It was initially fully dependent on groundwater, however, the reserves were insufficient, and artificial recharge was introduced to augment local groundwater supplies. The recharge system, using urban runoff and high quality treated domestic wastewater, has been in operation for more than 20 years.