

EXECUTIVE SUMMARY

An investigation into the problems associated with pollution of the water supply from the Vaal Barrage was initiated by the Water Research Commission (WRC) in 1974. Studies by the Hydrological Research Unit at the University of the Witwatersrand and by the Consulting Engineers Stewart, Sviridov and Oliver indicated that non-point sources, including mine residues, accounted for about 50 % of the pollution load in the Vaal Barrage. The contribution from these non-point sources has previously been estimated by subtracting known point source loads from the total loads measured.

This project was initiated in order to establish the total load of salts contributed by mine deposits to the salt load in the Vaal Barrage and also to identify those deposits which require control methods to prevent pollution.

A tripartite contract was entered into between the WRC, the Department of Water Affairs (DWA) and Steffen, Robertson and Kirsten (Pretoria) Ing (SRK) in August 1983 in order to carry out the investigation. The WRC financed the project, whilst installation and maintenance of instrumentation was carried out by the DWA. SRK provided professional and technical expertise and carried out the investigation.

The method of investigation involved detailed monitoring of three selected mine deposits in the City Deep area. From this detailed study, the source of pollution and the salt load from the study area and from each selected deposit were established. This constituted Phases I and II of the investigation. In Phase III an inventory of mine deposits in the Vaal Barrage catchment was carried out. Each deposit was classified according to a number of physical parameters relating to its pollution potential into a low, medium or high apparent pollution potential category. The total load produced by all mine deposits was then estimated by extrapolating from the loads calculated for the selected deposits in the study area.

The three deposits selected in the City Deep area included a sand dump (3A17), a well-maintained slimes dam (3L44) and a poorly maintained slimes dam (4L4).

Monitoring was continued over three hydrological seasons and the following data were collected:

- . continuous measurements of flow and conductivity at four gauging weirs
- . water quality samples taken from 13 surface water sampling sites, 12 boreholes and 5 auger holes
- . water quality samples taken during five individual storm events.

These data were then processed and analysed and the following parameters were obtained:

- . daily and monthly means and annual values of flow and conductivity
- . average chemical composition of the surface and ground water
- . relationships between continuous conductivity and both total dissolved solids (TDS), and sulphate
- . the variation in the chemistry of stream flow during storm events.

The major findings from Phases I and II of the investigation were as follows:

- i) The streams in the study area are perennial and are partly fed by ground water since flow was continuous throughout the study period despite prolonged periods without rainfall.
- ii) The chemical quality of water upstream from the monitored deposits is good but a marked deterioration in quality occurs in the vicinity of sand dump 3A17. This deterioration which persists into the eastern part of the study area where, however, no further deterioration was observed.

- iii) Examination of the variation in water chemistry during storm events showed that direct runoff serves to reduce the salt concentration in the streamflow. Salt loads during storms, however, were greater than would have been the case if only baseflow had occurred. Direct runoff is not considered to be a major contributor of salts to the stream network.
- iv) The investigation has shown that seepage from the deposits either directly into the streams, or indirectly via ground water which ultimately feeds the streams, is the probable source of the increased salt load in the baseflow of the stream as it passes the sand dump.
- v) The total annual load of dissolved salts exported from the study area may be divided into two components: the contribution from sources upstream of the study sites and the contribution from the study sites alone. In 1985, 2 300 t of dissolved salts were derived from sand dump 3A17 while the slimes dams made negligible contributions to the salt load. Since 3 300 t of the total load were contributed from sources upstream of the study sites, the total annual load of dissolved salts exported from the study area was 5 600 t.
- vi) The study had originally been designed on the assumption that runoff from the dumps would prove to be the major source of the salt loads contributed by the mine residue deposits. It has been shown, however, that this source is small and that in the study area the major contributor was seepage to a near surface ground water system which recharges the stream.

During Phase III of the investigation 273 deposits listed by the Chamber of Mines were visited. Excluding small deposits and those that had been reworked, 160 were classified of which 122 are slimes dams and 38 are sand dumps. The parameters used for classification included extent of vegetation, presence of toe dams, volume and surface area, and the pH, conductivity and permeability of the surface material. On the basis of

these parameters each deposit was inspected and sampled and then classified into a low, medium or high apparent pollution potential category. Those deposits with three or more of the following were classified as having a high potential; poor vegetation cover, no toe dam, large volume, low pH, high conductivity and high permeability. A total of 10 sand dumps and 15 slimes dams were classified into the high apparent pollution potential category. this classification allows a priority rating to be assigned to those deposits most urgently requiring remedial measures.

In the extrapolation of results from the detailed study to the whole Vaal Barrage catchment, several simplifying assumptions have been made, the most important being that only sand dumps are considered to contribute to the total load.

Estimations based on the information gathered during this study and on information supplied by the Chamber of Mines of South Africa indicate that approximately 50 000 t/a of salts seep from the sand dumps.

A presently unknown proportion of this emerges as recharge into streams and flows into the Vaal Barrage.

The major conclusions from this investigation were:

- i) The mine deposits in the catchment of the Vaal Barrage discharged approximately 50 000 t of salts into the near surface environment in 1985; it is not known what proportion of this is eventually transported by surface streams or ground water to the Vaal Barrage. The 50 000 t of salt originating from these mine deposits can be compared with a total load of salts into the Barrage estimated from other studies of approximately 400 000 Ha.
- ii) Direct runoff from the surfaces of the mine residues is not the major source of the high salt concentrations in the streamflow since these high levels exist in the baseflow.

- iii) Seepage from the mine deposits into the streams is the probable source of high salt loads.

This investigation has evaluated the transportation of salt loads from mine deposits to streams in the study area and has identified those deposits with a high apparent pollution potential.

It has also highlighted the need for further investigation into, in particular the following:

- . the movement of water through and out of mine residues;
- . the direction and rate of movement of ground water affected by seepage from mine residue deposits;
- . the changes in salt loads in the baseflow of surface streams in the vicinity of mine residue deposits;
- . the mechanisms and rates of recovery in the quality of streamflow during its downstream passage towards the Vaal Barrage.