EXECUTIVE SUMMARY

In previous work during 1990 at the COMRO test site, East Rand Proprietary Mines, Ltd, two pilot water-desalinating plants were operated in parallel on the same pretreated raw mine water. Both plants employed the seeded reverse osmosis principle. While not identical in capacity, their configuration differed in only one respect. In the first plant, known as the MLT plant, the raw mine water was fed into the seed reactor. In the second plant, known as the SPARRO plant, the raw mine water was instead fed into the slurry recycle stream, leaving the reactor and entering the modules of tubular membranes. The membranes in the MLT plant were able to maintain a stable flux rate at the design value; however, persistent membrane fouling, indicated by flux deteriorating to unacceptably low levels, occurred in the SPARRO plant.

It was postulated that this fouling was inherently due to the difference in configuration between the two plants. Accordingly, the "contaminants" in the raw mine water causing this fouling in the SPARRO plant would not do so in the MLT plant, because the raw mine water was fed into the seed reactor. There, these "contaminants" would be encapsulated in growing seed crystals as the reject stream, also entering the reactor, desupersaturated.

The present study was undertaken to determine the reaction kinetics within the reactors, and thereby ascertain the influence of these reactions upon observed membrane performance. The above postulate would be verified by operating the SPARRO plant in the "MLT mode" (by changing the configuration accordingly), and then in the SPARRO mode under otherwise identical conditions.

Due to various delays, it was only possible to carry out limited test work. The SPARRO plant was converted to operate in the MLT mode, and two experimental analyses of reaction kinetics were performed. Upon reflection, their results pointed to a logical conclusion. This was that, in the MLT mode of operation, blending of the supersaturated reject stream with unsaturated raw mine water results in a mixture of lower supersaturation, and consequently a far slower precipitation rate. Therefore, the likelihood that any "contaminants" in the raw mine water would be trapped within the matrices of growing crystals and be removed from suspension or solution is considered to be remote. Accordingly, there appears to be little merit in pursuing the study of reaction kinetics further.

During operation of the SPARRO plant in the MLT mode, membrane performance was monitored through detailed surveys of 30 individual modules. Over 1300 hours, overall salt rejection decreased, and flux increased, gradually. Of more significance was that, of all Three Banks, the modules in Bank 1 of the tapered module stack showed the best performance; while those in Bank 3 showed the worst performance. Although there was no time available to convert the plant back to the SPARRO mode, records of operation in the SPARRO mode during early 1992 showed similar membrane degradation. Therefore, this degradation does not appear to be due to mode of operation (plant configuration), but rather to a combination of phenomena associated with the increasing concentration of dissolved and suspended solids in the feed to successive rows of membrane modules.

Radioactivity may be one such phenomenon; radionuclides appear to be almost totally rejected by the membranes, even when their overall salt rejection is poor. This is an encouraging finding, suggesting that SPARRO systems may find application in removal of radionuclides from chilled service water for drinking by workers underground.

The work done to date nevertheless remains insufficient to conclusively identify the causes of the various forms of unacceptable membrane performance that have been observed on the SPARRO plant in all tests since 1989. If the SPARRO process is to be applied in full-scale improvement of water quality on mines, further work is essential to so identify these causes and modify plant design appropriately. Accordingly, it is suggested that, as the first phase of future work, an intensive, short-duration investigation be conducted with the following aim:

> To develop a conclusive statement with regard to the effects of the presence of radioactive isotopes in the feed water on membrane degradation in particular and on the performance characteristics of locally produced tubular cellulose acetate membrane modules in general.

It is envisaged that this investigation be carried out at the existing test facility at ERPM using a modified version of the SPARRO plant with a reduced number of membrane modules. The plant need to be operated in a manner to allow for detailed monitoring of selected modules within the membrane stack, in order to establish a pattern of membrane performance relating to the degree of concentration of radionuclides and other dissolved and suspended species in the feed water, over on operating period of about 15 000 hours.