Executive Summary

This research project forms part of a research program funded by the Water Research Commission that started in 2001 to critically assess the South African sludge legislation and revise the guidelines if necessary. This multidisciplinary research program includes the following projects:

- **WRC Project Number 1209:** An evaluation of dedicated land disposal practices for sewage sludge
- **WRC Project Number 1210:** Laboratory and field scale evaluation of agricultural use of sewage sludge
- **WRC Project Number 1240:** A technical and financial review of sludge treatment technologies
- **WRC Project Number 1283:** A metal content survey of South African sewage sludge and an evaluation of analytical methods for their determination in sludge
- **WRC Project Number 1339:** Survey and methodology for analysing organic pollutants in South African sewage sludge

The results of the research projects will form the knowledge base to start a participative process in 2003 to develop Edition 2 of the Permissible utilisation and disposal of sewage sludge.

This project had the following objectives:

- To evaluate different analytical methods for the determination of the Potentially Toxic Metals and Elements (PTME) content in sludge.
- To conduct a survey on the PTME and plant nutrient content of South African sewage sludge in order to determine disposal options according to the present guidelines.
- To classify sludge into types A, B, C or D according to the present guidelines.
- To determine the impact of the existing guidelines on the disposal options of South African sewage.

Seventy-two wastewater treatment plants were selected to represent different sludge types and sludge handling technologies in South Africa. Background information was gathered using a questionnaire and interviews with plant managers. Sludge samples (78) were collected at these selected wastewater treatment plants. These samples were analysed for microbiological, nutrient and PTME content. The PTMEs, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Zn, As, Se, B and F, were analysed using four extraction methods based on previous research, a literature survey and recommendations by the steering committee of this research project. The analytical data was used to classify the sludge and to determine the impact of the existing guidelines on the disposal options.

The completed questionnaires revealed a lack of information and knowledge at plant level with regards to responsible sludge management practices and sludge characterisation requirements. This was particularly evident in the rural areas of South Africa.

Anaerobic digestion of primary and humus sludge are still employed to stabilise the majority (57% mass basis) of the sludge included in this survey. The dewatering technologies used at the wastewater treatments plants included drying beds (35% mass

basis), belt filter presses (28% mass basis), paddies (9% mass basis), centrifuges (5% mass basis), and lagoons (4% mass basis). Where no dewatering technologies are employed, liquid sludge is often used for direct land application such as instant lawn cultivation. The majority (74% mass basis) of the surveyed sludge is not treated further than the traditional anaerobic digestion and activated sludge treatment. Both plants found in metropolitan city councils and plants in smaller town councils use composting while only metropolitan city councils employ pelletisation. The major sludge disposal methods employed by the wastewater treatment plants surveyed is alienation or selling (42%), used for municipal gardens (21%), used for instant lawn cultivation (12%), land application (12%). The remaining 13% of the sludge surveyed, is either stockpiled or landfilled. The classification of the sludge revealed that 51% of the sludge surveyed was a Type B sludge, 24% was a type A sludge, 14% complied to a type C sludge and the remaining 11% complied to a type D sludge.

Average total solids, volatile solids, alkalinity, pH and volatile fatty acids concentrations were recorded for activated sludge, heated digesters, cold digesters and products such as compost and pellets. The microbiological and nutrient quality of activated sludge, heated digesters, cold digesters and products such as compost and pellets were recorded as well.

The efficiency of the extraction methods, aqua regia (total), EPA 3050 (total), TCLP (leachable) and Parr Bomb (total), were compared. The aqua regia (total) extraction method was found to give higher results compared to the EPA 3050 (total) extraction.

The average PTME concentration of the sludge from the surveyed plants receiving industrial effluent (50%) was compared to the plants that do not receive industrial effluent. As expected, the PTME concentration (aqua regia total extraction) for sludge from the plants receiving industrial effluent was higher or similar than the average PTME concentration from sludge from plants receiving domestic effluent for all the PTMEs with the exception of B.

The PTME concentration of fertilisers was compared with that of the PTME concentration of sludge on a common load basis. Although it was expected that the PTME contribution from fertilisers would be insignificant, the results showed that this is not always the case. However, some fertilisers are enriched with PTMEs such as Zn. The results show that the F contribution from sludge is less in all cases compared to the contribution from the fertiliser samples.

The compliance to the Sludge Guidelines and related Addendum of the sewage sludge surveyed in this study was evaluated in terms of the leachable and total PTME content. None of the plants surveyed exceeded the TCLP (leachable) extractable concentration limits as specified in the Addendum of the 1997 Sludge Guidelines. The results from the total PTME extractions showed a different picture. The major PTMEs of concern are Ni and Zn. Sixty-one percent (61%) and 44 % of the total mass of sludge surveyed exceeded the Ni and Zn concentration limits respectively. A major fraction (40%) of the sludge surveyed did not exceed any of the total PTME limits. Thirty-five percent (35% mass basis) of the sludge surveyed exceeded on one or two PTMEs. Only 4% of the sludge surveyed, exceeded the limits for more than seven of the twelve PTMEs analysed for.

Thirty-three plants were sampled both in this study and the survey done by Smith and Vasiloudis in 1989. The PTME concentration of these 33 plants was compared to establish trends over the last decade. The largest change in compliance of the sludge included in the two studies, were evident for Ni and Pb. Compliance to the Ni limit increased, while compliance to the Pb limit decreased substantially. However, these findings could not be verified when all the data from both studies was analysed and compared.