SA waterbulletin

ISSN 0248 - 2244 VOLUME 15 NO 2 FEBRUARY/ MARCH 1989

WATER POLLUTION
Salt flow from mine dumps monitored

IRRIGATION
Research results will help irrigation planners in South Africa

WASTE WATER TREATMENT
WRC releases report on chemical phosphate removal

SYMPOSIUM ON WATER: LAWS AND MANAGEMENT

During the past 25 years, many water resources and environmental management strategies have been developed and implemented. As the next century quickly approaches, there is a need to review and assess the laws and programmes that have been employed. Those laws and programmes which have been successful must be retained whilst those that have failed or become ineffective should be relinquished or modified. This Symposium will critically examine current water laws and their impact on environmental management, especially in the South African context, with a view to making concrete recommendations for the designing of future water-related environmental management strategies.

WHO SHOULD ATTEND?

Water managers, resource planners, legal professionals, decision-makers, researchers and engineers, and all interested persons wishing to acquire a better knowledge of the current status of, and issues affecting, water law and management in southern Africa.

AUSPICES

The Symposium is being convened under the auspices of the Western Cape Region of the Limnological Society of Southern Africa and with the support of the American Water Resources Association.

DATE

Friday, 7 July 1989.

VENUE

Department of Zoology, University of Cape Town, Cape Town, South Africa.

PROGRAMME

Papers and posters will deal with topics on effective laws and regulations, communication of successes and failures, planning efforts and accomplishments and promotion of effective research.

The Limnological Society of Southern Africa will publish the Proceedings of the Symposium in the Southern African Journal of Aquatic Sciences.

Preliminary Programme

Keynote Address:
Prof F Visser, Institute of Foreign and Comparative Law, UNISA

National legislation (including the RSA Water Act)

Provincial ordinances

Local government bylaws

International aspects

Applications (including the implications of research on the development of Legislation and the future of integrated environmental management in RSA).

Discussion forum: The Way Ahead.

COSTS

Registration fee, payable by all delegates, is R50,00 (25,00 for students) including lunch, teas and Proceedings. A book display is planned. Enquiries regarding other exhibitions relating to the theme of the meeting should be directed to the Organizers.

PRELIMINARY REGISTRATION

Persons interested in attending this timely Symposium are asked to complete the printed reply card in this issue of SA Waterbulletin.

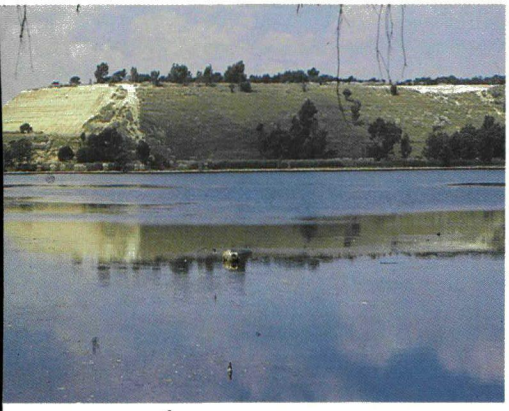
Enquiries:

Dr JA Thornton, Town Planning Branch,
PO Box 1694, Cape Town 8000.
Telephone: (021) 210-2149.
Fax: (021) 25-1497.

Volume 15 nr 2

SA waterbulletin

Februarie/ Maart 1989



p 4

p 16

p 24

Contents

Cover: Acid mine drainage on the East Rand.

SA Waterbulletin is a two monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organization established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source. Editorial offices: WRC, PO Box 824, Pretoria, 0001, Republic of South Africa. Tel. (012) 33-00340. Fax: (012) 70-5925 . Editor: Jan du Plessis. Asst Editor: Helene Joubert, Ed Secretary: Rina Human, Colour separations: Lithotechnik, Design: Nicola Kuyper, Printing: Creda Press, Cape Town.

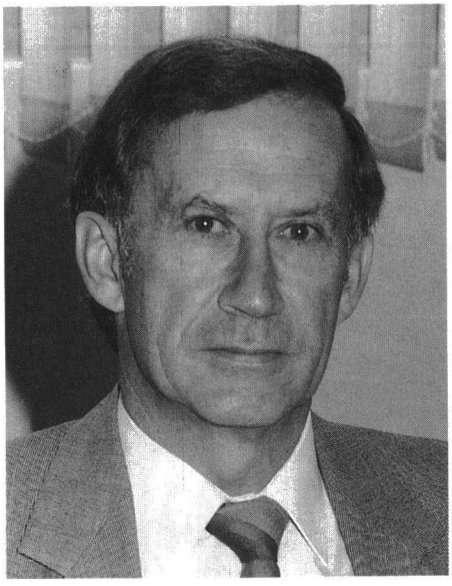
SALT POLLUTION OF MINE DUMPS MONITORED

G A JONES
S E BRIERLEY
S J J GELDENHUIS
J R HOWARD

RESEARCH ON THE CONTRIBUTION OF MINE DUMPS TO THE MINERAL POLLUTION LOAD IN THE VAAL BARRAGE

Report to the
WATER RESEARCH COMMISSION
by
STEFFEN ROBERTSON AND KIRSTEN
(PRETORIA) INC

WRC Report No. 136/1/89
SRK Report No. PT 3632/10



Dr Thys Pieterse, Research Manager, WRC.

A Water Research Commission project to evaluate the present contribution of mine dumps to the salt pollution in the Vaal Barrage cathment has recently been completed. The investigation, carried out by consulting engineers Steffen, Robertson and Kirsten (Pretoria) Ing, showed that in 1985 mine dumps in the catchment of the Vaal Barrage discharged approximately 50 000 t of salts into the near surface environment, of which an unknown proportion reached the Vaal Barrage itself. However, the researchers say that direct runoff from the mine dumps is not the major source of the high salt concentrations in the streamflow. These high levels exist in the baseflow. Seepage from the mine dumps into the streams is the probable source of high salt loads.

A final report with the full results of the study, entitled Research on the contribution of mine dumps to the mineral pollution load in the Vaal Barrage is now available, free of charge, from the Water Research Commission, P O Box 824, Pretoria 0001. To order, please complete the post card included in this Bulletin.

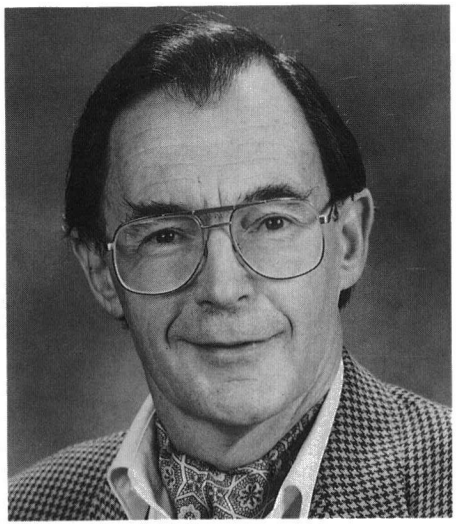
The project commenced in August 1983 when a tripartite contract was entered into between the Water Research Commission, the Department of Water Affairs and Steffen, Robertson and Kirsten (Pretoria) Ing (SRK) to carry out an investigation into the transportation of salt loads from mine dumps to streams in the Vaal Barrage catchment area.

The WRC financed the project, whilst installation and maintenance of instrumentation was carried out by the DWA. SRK provided professional and technical expertise and conducted the research.

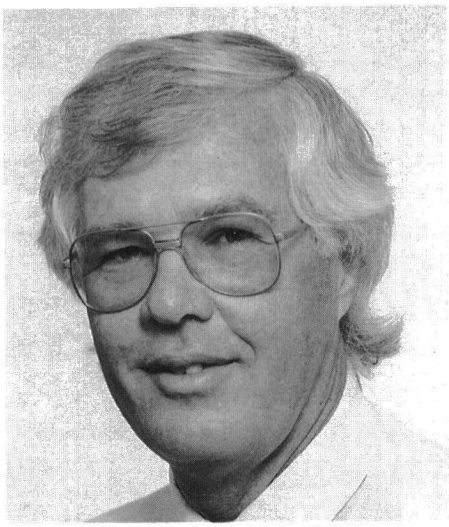
According to Dr Thys Pieterse, Research Manager of the Water Research Commission, a previous study into water pollution in the PWV area indicated that approximately 50 per cent of the pollution load of the Vaal Barrage was attributable to non-point sources, which include mine dumps in the catchment of the Barrage. However, the contribution of mine dumps per se to this pollution, was not known.

Dr Pieterse says current legislation specifies that the Department of Water Affairs is responsible for the control of pollution from all mines which were closed prior to 1956. It is also the responsibility of the Department of maintain pollution control measures of all mines closing after 1956. These functions of the Department involve large cost implications and it is, therefore, important to establish whether there is a significant water pollution potential from these mine dumps. In view of this the Department requested the WRC to initiate and support research on the contribution of mine dumps to the pollution load in the PWV area.

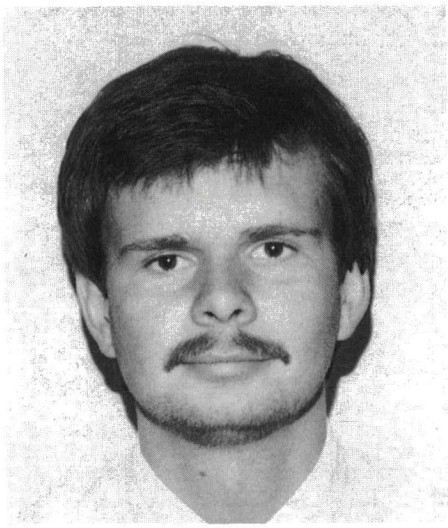
The method of investigation involved detailed monitoring of three selected mine deposits in the City Deep area. The three deposits were selected in consultation with the Chamber of Mines and included a sand dump, a well-maintained slimes dam and a poorly maintained slimes dam.



Mr G Jones, SRK.



Mr S Geldenhuis, SRK.



Mr JR Howard, Umgeni Water.

From this detailed monitoring study, the source of pollution and the salt load from the study area and from each selected dump were established. This constituted Phases I and II of the investigation.

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.

In Phase III an inventory of mine dumps in the Vaal Barrage catchment was carried out. Each of the 273 deposits 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 dumps was then estimated by extrapolating from the loads calculated for the selected dumps in the study area.

RESULTS

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

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.

The chemical quality of water upstream from the monitored deposits is good but a marked deterioration in quality occurs in the vicinity of sand dumps. This deterioration persists into the eastern part of the study area where, however, no further deterioration was observed.

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.

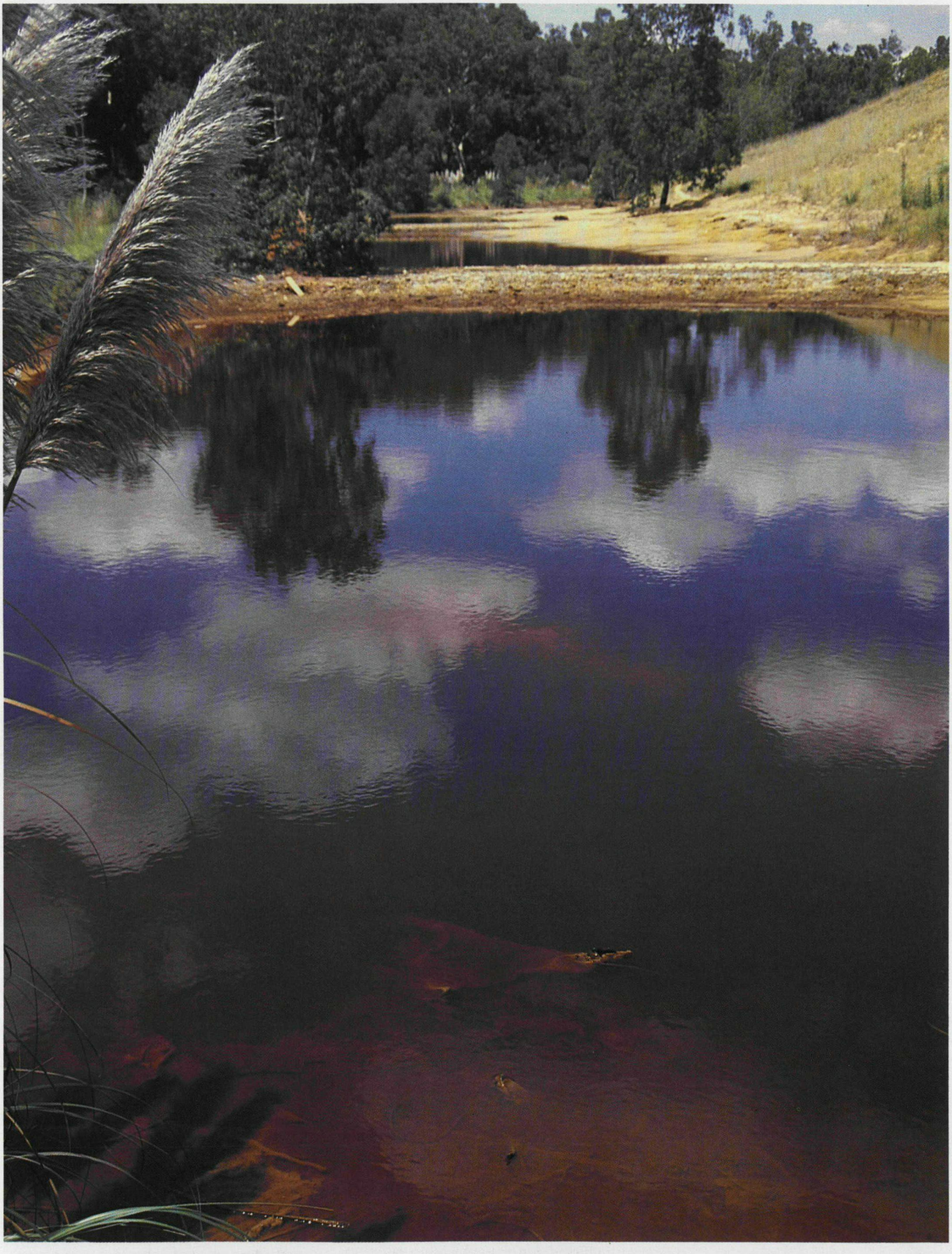
The investigation has shown that seepage from the deposits either directly into the streams, or indirectly via ground water which ultimately feeds the streams, is the probable source of the increased salt load in the baseflow of the stream as it passes the sand dump.

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 the sand dump while the slime 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.

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.

PHASE III

During Phase III of the investigation the 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 conduc-

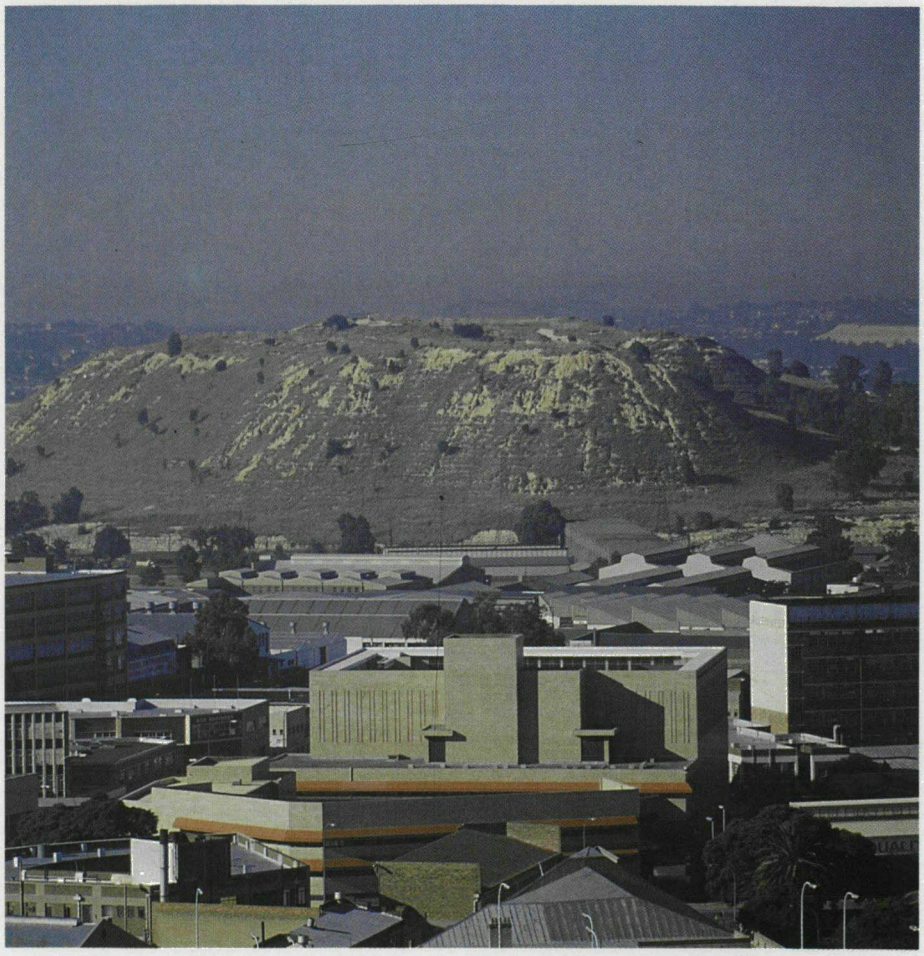


tivity and high permeability. A total of 10 sand dumps and 15 slimes dams were classified into the high apparent pollution potential category. This classification allows a priority rating to be assigned to those deposits most urgently requiring remedial measures.

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.



An old sand dump on the Reef.

CONCLUSIONS

The major conclusions from this investigation were:

- The mine dumps 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.
- Direct runoff from the surfaces of the mine dumps is not the major source of the high salt concentrations in the streamflow since these high levels exist in the baseflow.

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

Dr Pieterse says that one would like to put the figure of approximately 50 000 t of salt which originated from the mine dumps in perspective, by a direct comparison with the total salt load generated in the Vaal Barrage catchment during the study period of 1984/86.

"Unfortunately this is not possible due to a lack of information for these years. However, estimates by Stewart, Sviridov and Oliver (SS&O) for previous years are available.

"SS&O found, for example, for 1977/78 that the total salt load generated in the Vaal Barrage catchment was approximately 698 000 t, with the diffuse source's contribution as 398 000 t. The net discharge to the Barrage was approximately 627 t (resulting from point and non-point sources).

Dr Pieterse says the latest available figures from SS&O are for the 1982/83 hydrological year. It shows a total salt load of approximately 366 t with a contribution from the diffuse sources of 94 000 t. The net discharge to the Barrage was approximately 198 000 t.

It should be emphasized that the TDS loads calculated in the present investigation related to the vicinity of the mine residues themselves. The proportion of the load which actually entered the Vaal Barrage is, however, unknown."

COMRO develops guidelines for water treatment on South African mines

Pipe corrosion from mine service water.

COMRO (the Chamber of Mines Research Organization) is working on a new comprehensive water treatment project designed to produce guidelines for the various water treatment processes required on South African gold mines. The guidelines will be used to reduce working costs, protect health and anticipate impending water quality legislation. Dr HNS Wiechers, the Project Manager responsible for water research at COMRO's division of Environmental Engineering, says that the project will entail the development, refinement and application of mine water treatment processes such as neutralization, settling, filtration, disinfection and desalination. A text book containing guidelines for water treatment process design, operation and cost estimation will be produced. The text book will be supplemented with an accompanying computer based expert system as well as water management software.

COMRO recently estimated that the cost penalty for corrosion, erosion, scaling and fouling of underground mine water reticulation systems and equipment, as a result of the generally poor quality mine service water used in the gold mining industry, to be of the order of R200 million/annum. These costs arise as a result of the accelerated attack by poor quality water on pumps and pipework of reticulation systems causing a wastage of energy due to reduced pumping efficiency as well as increased maintenance and replacement costs. For those mines importing water from water boards, the steadily increasing cost of supply (about 13 to 18 per cent per annum), is also a cause for concern. To aggravate matters even further the demand for good quality water for underground cooling is projected to increase rapidly with increasing depth of mining. In order to reduce the costs associated with poor quality water the gold mining industry through COMRO has launched an extensive project to develop guide-

The COMRO water treatment test site at ERPM Hercules Gold mine on the East Rand.

lines for cost effective mine water treatment and water quality management. The project consists of a number of interdependent tasks, including more accurate quantifying the cost associated with poor quality mine water and the potential savings that can be effected by improved water treatment, development of improved water quality management practices, development of improved water treatment processes appropriate to deep underground mining, and the application and demonstration of full scale, on surface and underground, of appropriate water treatment technologies.

Researchers from COMRO's division for Environmental Engineering are currently conducting an extensive survey on a large number of gold mines to estcblish current water quality management practices, the water quality in the complex underground water reticulation systems, as well as water related costs. These included costs of water treatment, chemicals, make-up board water and maintenance costs of pumps, pipes and mining equipment using water. This information will be used to more accurately quantify the cost of poor quality mine water as well as establishing the potential savings that can be effected by improving water quality management and mine water treatment.

To assist the industry with water quality management COMRO has developed a mine service water circuit simulator, AQUA- Q. This user-friendly interactive computer program assembles a network of unit processes and interconnecting links to describe the underground mine service water system. Total dissolved solids, total suspended solids, calcium and sulphate concentrations, as well as pH are simulated at specific points within the system as functions of time. The program can be used for the design of underground mine service water circuits and the development of operational strategies, for example for neutralization and desalination.

Dr Wiechers says AQUA-Q is currently being developed further and refined with a number of areas receiving attention, such as:

An extensive survey on numerous mines is being undertaken in order to provide data against which the simulator will be further validated.

Additional water quality parameters are being considered and include chlorides, ammonia, magnesium and silicates.

The sophistication of the chemical equilibria sub- routine will be improved by including additional ion-pairs such as $CaHCO_3^+$, $MgHCO_3^+$ and $MgSO_4^\circ$, and considering gas/ liquid equilibria.

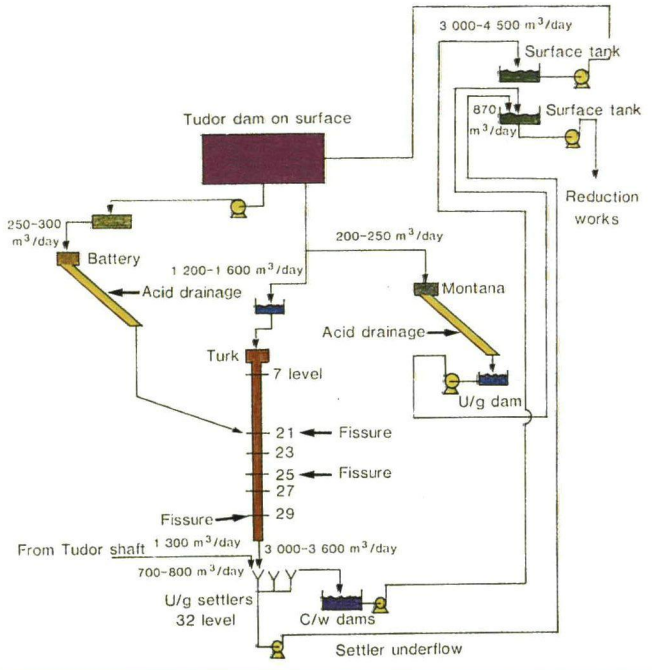
The algorithm used for modelling desalination processes will be refined by modelling pilot plant data, which has resulted from the COMRO test programme, for Electro-dialysis Reversal (EDR), Tubular Reverse Osmosis (TRO), Slurry Precipitation and Recycle Reverse Osmosis (SPARRO) and Freeze Desalination (FD) processes.

Empirical work on salination in stopes including aspects such as bacterial leaching and its control, as well as the effect of different explosives and the sulphur content of the pyrite bearing rock on water quality, is being planned to improve the current understanding of leaching in stopes and hence will allow the development of a more accurate model for leaching in stopes.

Other unit process models, for example models for direct-contact bulk air coolers and heat rejection cooling towers may be developed.

Dr Wiechers states that COMRO eventually wants AQUA-Q in a form where water managers in the mining industry can switch on the program

COMRO's guidelines will allow the mining industry to more cost-effectively use one of South Africa's most limiting natural resources, water.



Schematic diagram of a West Rand underground mine water circuit.

and it must be self-explanatory, as well as being of assistance in solving both their day-to-day and longer term problems related to water quality.

COMRO in collaboration with the Water Research Commission, various mine groups and individual mines, as well as equipment suppliers, specialist water consultants and various research institutions, has evaluated a number of water treatment processes for the improvement of mine water quality. These include a variety of processes for the removal of suspended solids from mine water, for example different types of settlers and filters, and desalination processes such as electrodialysis reversal and tubular reverse osmosis. The results of the research and guidelines for the application of these processes are currently being written-up for release to the industry.

Extensive pilot plant evaluation has been undertaken on a process for the high rate settling and filtration of mine water. This process which utilizes so-called ''flocculating cylinders'' has proved to be capable of operating at very high upflow velocities and filtration rates, and produces high quality water under conditions of highly variable hydraulic and solids loading. A full scale trial is currently underway at a gold mine on the West Rand where two cells of an existing settler have been converted. Results to date look very promising and indicate that settling rates of at least five times higher than those used in conventional settlers are possible. The process holds potential for upgrading currently overloaded settlers. Where new settlers are required, smaller high rate settlers with associated cost savings in capital and the excavation costs can be considered.

DESALINATION

Research by COMRO on the desalination of spent mine service water from gold mines over the last five years has indicated that one of the major problems in this field is the scaling nature of the majority of these waters. Scale formation, particularly calcium sulphate scale, can be disasterous for membrane processes such as EDR and TRO. For this reason COMRO in collaboration with the Water Research Commission, a local membrane manufacturer and ISCOR, are undertaking a joint project to develop a desalination process which can cost-effectively desalinate scaling mine waters.

The process, referred to as the SPARRO (Slurry, Precipitation and Recycle Reverse Osmosis) process, was developed based on past research on another seeded reverse osmosis process which proved to be technically feasible but had a number of major engineering drawbacks. A 0,85 l/s SPARRO pilot plant is currently under evaluation at an East Rand mine, novel engineering features and the economic feasibility of the process are being critically assessed.

The guidelines to be developed by COMRO will be based on information and experience gained by COMRO and its collaborators, mining groups and individual mines, specialist water consultants, research institutions and chemical, equipment and instrument suppliers. It is planned to release results of the COMRO Water Treatment Project to the gold mining industry during the course of the project, when intermediate objectives have been achieved. At the end of the project, COMRO will be in a position to provide definitive guidelines on water treatment and water quality management. This will allow the industry to more cost-effectively use one of South Africa's most limiting natural resources, water, as well as being in a better position to limit pollution of the water environment.

POST CARD

Postage stamp required

Mrs Tineke van der Schyff
c/o Water Research Commission
P O Box 824
PRETORIA
0001

Insert to *SA Waterbulletin* February/March 1989.

BOOK ORDER

Complete and return to the Water Research Commission, P O Box 824, Pretoria 0001.

Please send:

.....copy/copies of: *Research on the Contribution of Mine Dumps to the Mineral Pollution Load in the Vaal Barrage* by G A Jones, S E Brierley, S J J Geldenhuis, J R Howard.

.....copy/copies of: *Crop Water Requirements, Deficits and Water Yield for Irrigation Planning in Southern Africa* by M C Dent, R E Schulze, G R Angus.

.....copy/copies of: *Development of a Portable Toxicity Detector for Water* by W S G Morgan, P C Kuhn.

.....copy/copies of: *Evaluation and Optimisation of Full-Scale Chemical Phosphate Removal in Biological Sewage Treatment Processes* by A S Louw, H J Basson, W V Alexander.

Name: .....

Address: .....

.....

Telephone No.: ..... Postal Code: .....

Signature: ..... Date: .....

REGISTRATION CARD

Dr J A Thornton
Town Planning Branch W/S 4151
P O Box 1694
CAPE TOWN
8000

Insert to *SA Waterbulletin* February/March 1989.

REGISTRATION CARD

LAW SYMPOSIUM – 7 July 1989

Please complete and return this card as soon as possible together with your cheque for R..... made payable to the Limnological Society of Southern Africa (Western Cape Region) as registration fee for ..... persons

Name: ..... Title: .....

Organisation: .....

Address: .....

.....

Telephone No.: ..... Postal Code: .....

Signature: ..... Date: .....

POST CARD

Postage stamp required

The Chairman (Prof J F van Staden)
Analytica '90
Department of Chemistry
University of Pretoria
PRETORIA
0002, South Africa

Insert to *SA Waterbulletin* February/March 1989.

ANALYTICA '90

March 18-23 1990

PROVISIONAL REGISTRATION FORM

Please type or print clearly

Return before June 30, 1989

Prof/Dr/Mr/Mrs/Miss .....

Organisation .....

Address .....

..... Code..... Tel: .....

Please indicate the following by a √ if applicable

Member of: ☐ SACI ☐ SASS/SASV ☐ SAIM/SAIEA ☐ Full time student

☐ I wish to attend **Analytica '90**

☐ I intend to submit a paper and prefer the following mode of presentation:

☐ Oral presentation 20 minutes ☐ Poster presentation

Provisional Title: .....

.....

☐ My company intends/I intend to exhibit at **Analytica '90**.

Enquiries: Prof J F van Staden (012) 4202515 (Voorsitter/Chairman)
Dr P L Kempster (012) 8080374 (Sekretariaat/Secretariat)

Engineers conducting the National Industrial Water and Waste-Water Survey (NATSURV) for the past five years, have identified a number of problem areas, common to many industries, where research is needed to assist factories in improving their water and effluent management.

These problems range from the development of a reliable and inexpensive automatic sampler for obtaining effluent quality data to combining effluents from two or more factories before treatment and discharge.

A list of some of the problems are published here as proposed research projects and readers are invited to comment and investigate the possibility of submitting research proposals on these problems to the Water Research Commission.

For further information please contact Dr OO Hart, research manager, at the Water Research Commission, PO Box 824, Pretoria 0001. Telephone: (012) 3300340.

The National Industrial Water and Waste-Water Survey (NATSURV) was initiated by the Water Research Commission in January 1984 in collaboration with the Department of Water Affairs.

The aims of the project are to establish a data base containing information on the South African industries' water intake, raw materials, products, effluent quality and quantity of industrial waste as well as to identify areas where research is needed to assist the South African industry in improving their water and effluent management at minimum cost.

Results from the NATSURV industry survey are reported in the form of industry guides. These are written as short summaries of all the relevant information collected during the survey of a particular industry and are aimed at industries, legislators, researchers and local authorities.

Copies of the guides are available from the Water Research Commission, free of charge.

NATSURV HIGHLIGHTS RESEARCH NEEDS

Proposed research projects

BOTTLE WASHING

Bottle washing produces a relatively weak effluent containing caustic soda. Research into the treatment of this effluent could lead to the recycling of bottle washing effluents. Applicable to brewery, dairy and soft drink and carbonated water industries.

COOLING TOWER BLOWDOWN

Evaporative cooling towers discharge water for the control of TDS concentration in the system. Volumes are substantial. Research using membranes, both RO & EDR could be undertaken to quantify recovery at factories (medium scale) and power stations (large scale).

OILY EFFLUENTS

Conventional method is to "crack" the effluent with sulphuric acid and float off the oil. This is only partially efficient and also adds large amounts of TDS to effluent. There is an absence of information on membrane treatment of such effluents, which might produce a viable alternative and probably a high quality product.

SPRAY DRYING

In the manufacuture of baby foods, a large quantity of water is added to make compounding easier. The product is then spray dried and all the water is lost to the atmosphere. Other industries which spray dry are in a similar position. Research into an economically viable method for recovering this water would be worthwhile.

COOLING TOWERS

Reportedly two-thirds of all water used by industry is employed in cooling systems. The mechanical aspects of the systems seem to receive minimal attention e.g. inlet spray nozzles, make-up valves, blowdown systems etc. An advisory document outlining installation, operation and maintenance criteria for cooling towers would benefit industry.

A desk study of sludge recovery and brine disposal from cooling tower blowdown. This could be extended to include a review of the treatment chemicals added to cooling tower make-up water, in particular the use of phosphates and sodium salts.

DEMINERALISATION BY INDUSTRY

Increasing mineralisation and salinity of the country's water supplies is a serious problem. Industry frequently requires the pre-treatment of intake water to achieve a suitable quality which is traditionally done via the ion-exchange process. Recent technological advances in such fields as electrodialysis, electrodialysis reversal, multistage evaporation etc. should be promoted where appropriate. The project would involve an evaluation of alternative processes and assess the suitability of each to specific industrial applications.

SMALL EFFLUENT TREATMENT PLANTS FOR INDUSTRY

Increasing charges levied by municipalities for the acceptance of industrial effluents have forced many factories to install an on-site treatment facility. The production of a simple guide to effluent treatment plants for small industries would be well received. It would be important to include adequate cost data based on life-cycle costing. It is envisaged that presentation in the form of a mathematical model including the civil, electrical and mechanical installation would prove the most useful.

IN-SITU CHECKING OF WATER METERS

The accuracy of water meters deteriorates with age. This leads to errors in the measurement of water intake. Due to recent technological advances in-situ calibration is now possible. It has been suggested that future water meter installations at industrial premises should include a sufficiently long upstream straight pipe length to facilitate the installation of check flowmeters.

It is proposed that the units of accuracy of such an arrangement should be determined for the range of pipe diameters, materials and flows encountered in practice.

EFFLUENT SAMPLING PROGRAMMES

A flow-related composite sample is very accurate but expensive. Therefore time-related sampling being easier and cheaper, is much more common. The optimum number of time- related sub-samples required to give a representative composite sample is presumed to be industry related. A project to empirically determine the pattern and optimum number of samples would be of great long-term benefit.

THE USE OF ACIDS IN THE METAL FINISHING INDUSTRY

Acids are used extensively for surface preparation. A large number of metal finishing works encountered by NATSURV use sulphuric acid whereas hydrochloric acid would be preferable because it can be regenerated. The need exists for a study of the above industrial use of these and other acids.

MAINTENANCE OF ADEQUATE WATER RETICULATION DRAWINGS BY INDUSTRY

NATSURV has found that few industrial premises maintains adequate drawings of the water reticulation, sewerage and stormwater drainage systems. Drawings of these systems are an essential prerequisite for efficient water management. A system of control could be initiated by stipulating the submission of proper layout drawings as part of an application for a water permit. A project aimed at identifying scope and cost of such a system would be of great benefit.

INDUSTRY'S AWARENESS OF WATER RELATED INFORMATION SERVICES

NATSURV's experience of industries which have installed water treatment equipment has been lack of back up information. Since the SA Water Information Centre offers an excellent, low cost service, it is disturbing that industry remains on the whole uninformed. An investigation into the dissemination of water related information should be carried out with the aim of improving lines of communication.

COMPLIMENTARY EFFLUENTS

Industry produces a wide range of effluents, some of which could be regarded as complimentary to each other e.g. acidic, basic. A situation may exist where adjacent premises are separately treating effluents which are complimentary before discharging each to the same watercourse. The benefits of combining effluents before treatment and discharge are obvious. A project which would report on complementary combinations of effluents from major industries would be of value as a planning tool for future industrial development.

REUSE OF PHOTOGRAPHIC INDUSTRY EFFLUENT

This industry's effluent consists largely of rinse water containing various metals which make it unsuitable for reuse without treatment. Research into ways of treating this effluent for reuse could considerably reduce the volume of water used by the photographic industry as a whole, as rinsing is by far the major use of water in the industry.

DAIRY CLEANING-IN-PLACE (CIP) EFFLUENT

The major area of water consumption in the dairy industry is in CIP. Depending on the type of products produced this may comprise 30 to 70 per cent of total consumption. An investigation into suitable effluent treatment systems for CIP effluents could result in the reclamation of sufficient water to significantly reduce fresh water consumption.

ANODE RECOVERY FROM PLATING EFFLUENTS

Effluent from the electroplating industry contains comparatively high concentrations of various metals. In recent years cost of metal anodes have risen substantially making recovery of metals in element form increasingly attractive. Simultaneously advances have been made in the field of membrane separation and it is suggested that research be initiated into the possibility of combining reverse osmosis separation with electrolysis to recover metals sufficiently pure for use as anodes.

A Beer brewery. The sorghum beer industry in SA consumes some 3,6 million m^3 water annually.

NEUTRALIZATION OF PLATING EFFLUENTS

The plating industry produces effluents which are highly saline as well as being highly acidic and alkaline. A fairly simple way of treating plating effluents is to combine them in such a way as to produce a neutral effluent which can undergo further treatment in order to make most of the water available for reuse. Research could be carried out to examine the optimum combinations of various effluents as well as the type of process control required to achieve this.

REUSE OF CONDENSATE AT VEGETABLE OIL MILLS

Bulk storage of oil prior to refining requires large additional quantities of steam to prevent crystallisation of the oil before pumping to the refinery. Steam therefore accounts for 50 to 75 per cent of the total water usage at a typical oil mill/refinery. Steam used for vacuum raising is usually condensed by direct contact cooling, rendering it unsuitable for reuse in the boilers. This water is subsequently used in a barometric cooling circuit for use as the direct contact cooling medium.

Steam used for storage heating however passes through coils inside storage vessels and is then theoretically suitable for reuse in the boilers. Risk of contamination and subsequent failing of the boiler tubes results in condensate being used for floor wash water. A simple system for fat removal would allow the reuse of this condensate as a high quality water.

REDUCTION OF Na^+ AND SO^{2-}_4 IN FINAL OIL REFINERY EFFLUENT

Crude vegetable oil as recovered from seed contains a significant quantity of free fatty acid (FFA) and lecithin gums which together with odours and colours must be removed before product quality is obtained. Two distinct processes are in commercial use in SA for this purpose.

- ☐ physical refining
- ☐ chemical refining

Some oils cannot be refined by physical means, and chemical refining involves a neutralization stage in which FFA are

removed as soap solution after the addition of aqueous NaOH solution. This solution contains a significant quantity of vegetable oil which is usually recovered by means of sulphuric acid addition. The recovered "acid oil" has a considerable resale value but results in the discharge of high concentrations of sodium sulphate. Subsequent neutralisation with caustic soda further exacerbates the Na+ problem. Two possible solutions are

a) use of a non sodium alkali for neutralisation of FFA in crude oil and of effluent from acid oil recovery
b) recovery of sulphur from highly saline effluent.

Typical oil refinery effluent contains SO^{2-}_4 at concentrations of up to 20 000 mg/l after dilution with washdown water from the factory site. Recovery of sulphur from a segregated effluent stream from the acid oil-soap splitting plant should therefore be investigated.

REDUCTION IN SODIUM CONTENT OF ELECTROPLATING EFFLUENT

In the electroplating industry caustic is used for precleaning components prior to metal deposition. These caustic solutions are dumped periodically when free and emulsified oil content reaches unacceptable levels. The use of a recirculatory filter system would reduce the frequency with which the caustic solution needs changing. Suitable filter media or membranes capable of removing all of the oil content need to be identified.

Additional caustic is frequently used for the neutralisation of final effluent and sometimes for the precipitation of heavy metal hydroxides. Many plating shop operators are unaware of the undesirable nature of sodium salts in wastewater. It is suggested that the use of lime as an alternative be strongly promoted amongst the electroplating fraternity.

RETURN OF MALT STEEP LIQUOR TO MASH

An investigation of the effect on malt beer quality of returning malt steep liquor to the mash is proposed. It is feasible to mill malt dry but in many breweries major equipment changes would have to be made. If the steep liquor used in the milling equipment were returned to the mash instead of being discharged to drain, a reduction of approximately 500 kg of COD per 1 000 kl brewed could be achieved.

USE OF SPENT GRAIN AS ABSORBENT OF EFFLUENT ORGANIC MATTER

An investigation into the feasibility of using spent grain from the malt brewing process as an absorbent of organic matter is proposed. It is believed that centrifugation can reduce the moisture content of spent grain by about 65 per cent. The volume of recovered water would then be about 90 kl/1 000 kl beer brewed. Assuming that dewatered spent grains could absorb the same volume of brewhouse effluent as the volume of centrate removed then a reduction of approximately 1 250 kg COD/1 000 kl brewed could be expected.

THE TREATMENT AND DISPOSAL OF WHEY EFFLUENTS FROM DAIRY INDUSTRY

Whey is high in protein and highly biodegradable. In Europe byproducts are made from this whey and sold to the public. Similar trials in SA have proved unsuccessful as little interest was shown by consumers. Research into the extraction, purification and marketing of this protein could result in an increased interest in effluent treatment in the dairy industry and a better utilisation of a potentially valuable resource.

CENTRALISED WASTE TREATMENT FACILITIES (CWT)

This involves

a) Conducting a waste inventory to identify all the waste streams in an area.
b) Quantifying the different waste streams.
c) Specifying treatment systems and disposal practices.

CWT's are advantageous since they can drastically reduce the cost of treating industrial wastewater because of economies of scale. Further, CWT's are operated by professional waste handlers who can often treat and manage the waste more efficiently than the firms which generate it, which are not primarily in the waste treatment business. CWT's can also dramatically increase the potential for chemical recovery as well as decreasing the burden of sludge handling and disposal.

STANDARDIZED CHARGES FOR INDUSTRIAL EFFLUENTS

There is considerable variation in the formulae used by municipalities to calculate charges for industrial effluents. Municipalities seldom charge for components in effluent other than organic load or suspended solids. Many components in industrial wastewater are not removed by sewage works. Industry is reluctant to motivate funding for effluent treatment plants when there is no direct recovery of cost such as would be the case if they were paying for all the polluting components in their effluent.

While work has already been undertaken on the standardisation of municipal effluent tariff structures, it appears that reworking and updating the previous proposals would be advantageous. A standard formula based on volume and strength is required which would allow individual municipalities to recover their cost of operation. Thus while the formula would be standardised, the actual charge would still vary from one municipality to another.

An important additional component would be the recovery of revenue from industry to offset the cost of environmental impact brought about by components in industrial effluents which are not removed by sewage works.

WATER USAGE CONTROL FOR SORGHUM BEER INDUSTRY

The sorghum beer industry in SA is a significant water user, consuming some 3,6 million m3 water annually. This is more than double that of the barley beer industry's consumption. A system to control water usage in a barley beer brewery has been developed and is currently undergoing trials. It involves identifying the main water-consuming areas and using computer software to produce specific water intake (SWI) figures for each area on a daily basis or as required. This allows easy identification of high water-consuming areas of the plant and enables management to quickly take steps to rectify any problems encountered. There are considerable differences in water management practices in the sorghum beer industry. A system similar to that designed for the barley beer industry would be very useful in improving water management and awareness of water conservation in the

INVESTIGATION OF SIEVING FOR SORGHUM BREWERY EFFLUENT

Tests have indicated that it is possible to successfully sieve sorghum brewery effluents and obtain reductions in chemical oxygen demand of approximately 20 per cent (using a 28 μm sieve). An investigation of the types and sizes of sieve which are suitable for this application followed by longer term trials to examine the effectiveness of sieving in lowering the organic content of these effluents would be of considerable interest. This could be combined with trials examining the applicability of gravity settling of solid material in the effluent prior to sieving.

ANAEROBIC TREATMENT OF VEGETABLE OIL EFFLUENTS

Anaerobic treatment of readily biodegradable effluents, particularly from the food and beverage industries, is receiving much attention worldwide. Research work is being conducted in Malaysia on the applicability of the technology to the treatment of palm oil mill effluent. Although palm oil mill effluent is of a very different nature from effluents generated in local oil plants, the anaerobic treatment of such effluent should be investigated, especially if other highly biodegradable effluents are available from nearby sources.

OPTIMIZATION OF SOLAR EVAPORATION POND SYSTEMS AS A MEANS OF EFFLUENT TREATMENT FOR SLIME WASTEWATER

The NATSURV project has encountered many examples of the use of solar evaporation as a low cost alternative to desalination by reverse osmosis or thermal/mechanical evaporation. However, in spite of high levels of solar irradiation and abundance of land in many areas of the country, there is a general feeling of distrust of evaporation ponds because they seldom work as anticipated. A number of opportunities exist to help improve the operation of evaporation pond systems. These include:

a) lime-soda treatment to precipitate calcium at an early stage, reducing salinity and accelerating evaporation

b) operating sections of the system as batch processes, evaporating to near-dryness in rotation

c) using the system as a low-cost volume reduction process, prior to mechanical evaporation, for example.

If these possibilities could be defined with confidence when considering solar evaporation, the system could be prescribed in detail according to an established basis of design and much of the uncertainty regarding the effectiveness of the system would fall away. It is suggested that research into this complex subject be encouraged as it would be of tremendous benefit to designers and legislators alike.

THE DEVELOPMENT OF GUIDELINES FOR LOCALISED AND CENTRALISED BALANCING AND EQUALIZATION OF INDUSTRIAL AND COMBINED EFFLUENTS

The industrial sector discharges large quantities of effluents to sewerage systems which often fluctuate widely in terms of flow rate, constituent components and mass loadings. These discharges cause major problems for the receiving authorities, particularly due to short term overloading of sewerage reticulation systems and peak loads arriving at sewage works in an uncontrolled manner.

Some municipalites have installed their own balancing facilities at their sewage works intake in order to overcome these problems while others induce industry to store industrial effluents on site for night time discharge.

Each system has its merits and drawbacks but there is a clear need to develop appropriate guidelines for the correct design and implementation of both localised (on site) and/or centralized (sewage) works effluent balancing. The former should probably be developed along industry-specific lines and the latter should adopt as a major criterion the optimum use of available or planned sewage treatment facilities.

INCREASING LEVELS OF AWARENESS IN SA OF THE NEED FOR WATER CONSERVATION

It is clear from the vast majority of industrial premises visited during the course of the NATSURV project that the general level of awareness of the importance of water conservation in SA is very low. Apart from a few notable exceptions, industrial groups have no co-ordinated plans to reduce or control their water consumption in the future, and this can only be attributed to ignorance of the problems on the part of management and staff. The benefits of a concerted national campaign to increase the levels of awareness of water-related problems amongst the population groups would be considerable.

IMPROVEMENTS IN STEEPING TECHNIQUES IN THE SORGHUM BEER INDUSTRY

Steeping of sorghum grain as part of the malting process requires some 57 per cent of the total malting industry's water intake. This represent about 358 000 m^3/annum of water. Investigations into better steeping techniques including the possibility of reuse of water if technically and economically feasible, should be considered.

OPTIMIZATION OF DAIRY TANKER CLEANING PROCEDURES

At the centre of all dairy industry operations is the dairy tanker which transports raw milk from milking parlours to factories for further processing. These vehicles are cleaned on the inside and outside every day and this operation requires a significant amount of water. This operation involves the flushing out of some raw milk from the tankers which is discharged as effluent. This effluent can have very high COD figures which indicates the presence of relatively large quantities of milk which results in strain being put on the receiving sewage treatment works, and also represents financial loss from the factory's point of view. Better control of tanker cleaning would result in optimum use of water and also reduce the high organic loads being discharged to municipal treatment facilities.

DEVELOPMENT OF A RELIABLE AND INEXPENSIVE AUTOMATIC SAMPLER

One of the keys to better effluent management is the ability to obtain reliable effluent quality data on a regular basis. This is normally done by means of an automatic sampler, but the cost is often prohibitive for the smaller factory and frequently the samplers available have proven themselves to be at best temperamental and difficult to operate and at worst completely unreliable. A locally produced, robust and reliable alternative would be welcomed by all those involved with sampling industrial effluents.

WRC REPORT

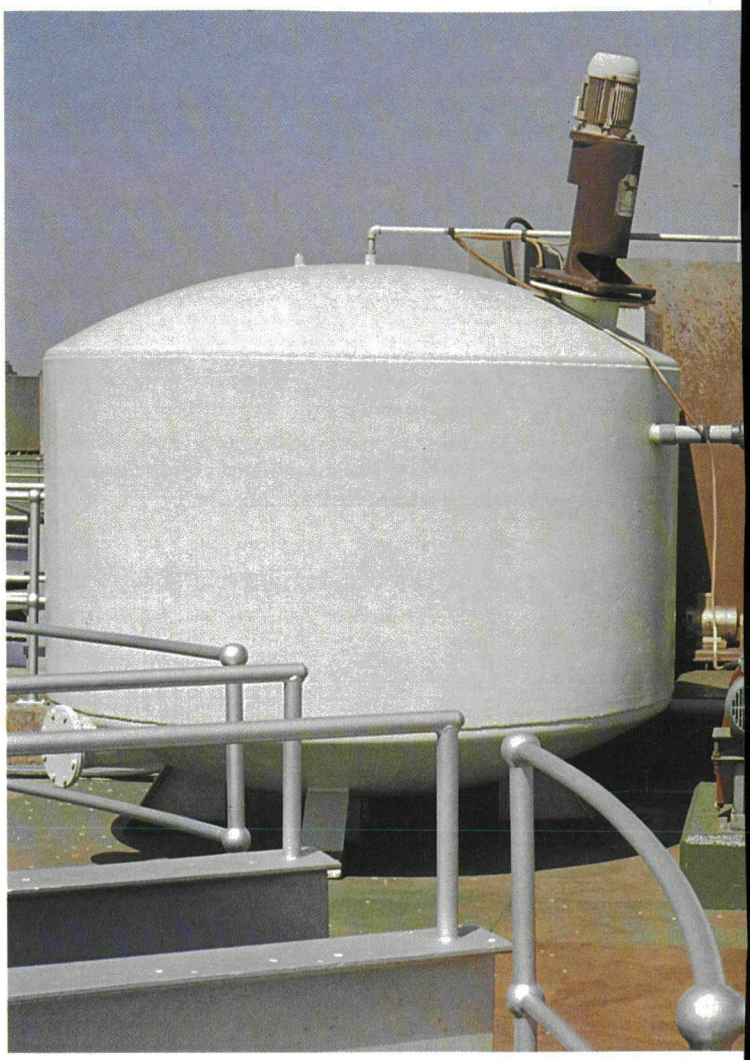
CHEMICAL PHOSPHATE REMOVAL PROVES SUCCESSFUL

The introduction of chemical phosphate removal at Boksburg's Vlakplaats Water Pollution Control Works has significantly reduced phosphate levels in the final effluent discharged from the Works.

According to a research report recently released by the Water Research Commission, the addition of chemicals to the biological sewage purification process at Vlakplaats has resulted in a total phosphate removal of 25 to 79 per cent.

The report says in terms of orthophosphate PO_4-P/d load on the environment, the conventional unit at Vlakplaats discharged 324 kg P/d, whereas the chemically treated unit only discharged 54 kg PO_4-P/d. The removal of organic and nitrogenous matter remained essentially unchanged. However, chemical treatment resulted in an increased chloride content and decreased alkalinity of the treated water, as well as slightly higher iron concentrations. The total treatment cost rose by about 30 per cent.

The report entitled Evaluation and optimisation of full-scale chemical phosphate removal in biological sewage treatment processes is based on research results generated during a research project undertaken by the Town Council of Boksburg and Scott and De Waal Inc. on behalf of the WRC.



Currently about half of the sewage treated in the sensitive catchments in South Africa is purified by means of the biological filter process. The popularity of this process can be attributed to its low maintenance requirements, low energy usage, stability and reliability, as well as its compliance with the General Standard for effluents. A serious limitation of the process, however, is its inability to remove phosphate biologically to any significant degree.

Methods for upgrading of the biological filter process for the removal of phosphate have been developed and tested in South Africa. However, criteria for the optimal design and operation of such processes were lacking. In particular, there was a need for the development of a chemical dosing strategy to minimise chemical consumption, but assure the attainment of the effluent phosphate standard for at least 95 per cent of the time. The advantages of a process which is operated optimally are minimisation of:

Copies of the report are available from the Water Research Commission, P O Box 824, Pretoria 0001. Tel. (012) 33-00-340. To order, please complete the Post Card in this Bulletin.

Hydrologists and SAICE want closer cooperation

During the past year there have been several discussions between SANCIAHS and the South African Institution of Civil Engineers (SAICE) on the participation of South African hydrologists in activities of SAICE. The outcome was that SAICE has suggested that hydrologists registered with SANCIAHS become:

- ☐ Participants in the Division of Water Engineering of SAICE and
- ☐ Companions of SAICE.

The main motivation of such a move is to foster closer cooperation between hydrologists and civil engineers in the water field. It will provide hydrologists with the opportunity of active participation in a fully-fledged professional society, something that SANCIAHS cannot be. The offer from the Division would provide a 'home' for hydrologists, particularly in the surface water field, where no existing society is active. To promote cooperation and exchange of information the Division has also nominated a representative to serve on SANCIAHS. For the above reasons SANCIAHS would like to recommend that individual registered hydrologists register with the Division.

Every applicant for admission as a participant of the Division must have attained a standing in his own profession comparable to that of Graduate in the Institution. Participant fees now stand at R34,00 per year.

Besides receiving the journal "Civil Engineer of South Africa" participants would be notified of all activities of the Institution at the national and branch levels. A major benefit would be participation in monthly branch meetings. Participants may obviously also come forward with their own themes for such meetings. Such branches (formal and informal) now exist in the following centres:

Western Transvaal, Vaal Triangle, Kimberley, Port Elizabeth, Pretoria, South West Africa, Far Northern Transvaal, Witwatersrand, Pietermaritzburg, Durban, East London, Bloemfontein, Western Cape, Richards Bay, Welkom, Drakensberg, Southern Cape, Transkei, Upington, Lowveld, Mmabatho.

Applications should be routed via SANCIAHS so that the response can be monitored.

For further information contact Mr H Maaren, research manager, at the Water Research Commission, PO Box 824, Pretoria 0001. Telephone number: (012) 3300340.

Two chemical storage tanks at Boksburg Vlakplaats Water Pollution Control Works.

- ☐ chemical usage,
- ☐ sludge production,
- ☐ effluent salinisation,
- ☐ treatment costs.

A considerable degree of uncertainty existed as to the additional volumes and masses of sludge produced when a conventional biological filter treatment works was upgraded for chemical phosphate removal. Uncertainty also existed considering properties of the mixed biological/chemical sludges formed in these processes. This information is crucial for the design of new works, as well as for upgrading existing works for phosphate removal. Of overall importance is the incremental cost associated with the introduction of phosphate removal.

During 1982 the Town Council of Boksburg commissioned a third 18Ml/d module of its Vlakplaats biological filter sewage treatment works. This module made provision for chemical phosphate removal and hence made it eminantly suitable for obtaining the information outlined above. An agreement to obtain this information was entered into between the Water Research Commission, the Town Council of Boksburg and Scott and De Waal Incorporated towards the end of 1984.

The experimental investigation lasted twenty-seven months (from January 1985 to March 1987). During this period the Vlakplaats Works was intensively monitored, leading to a better understanding of the overall functioning of the biological filter process, both with and without chemical addition for phosphate removal.

The introduction of chemical phosphate removal at the Vlakplaats Works resulted in significantly improved phosphate removal, i.e. from 25 to 79 per cent (as total phosphate). In terms of the orthophosphate load discharged to the water environment, chemical phosphate removal resulted in a decrease from 324 to 54 kg PO_4-P/d. The removal of organic and nitrogenous matter remained essentially unchanged. The use of ferric chloride did, however, result in an increased effluent chloride concentration and a decreased alkalinity.

Introduction of chemical phosphate removal at the Vlakplaats Works to comply with the effluent phosphate standard resulted in an increase in the total treatment cost of about 30 per cent. The 95 per cent compliance with the effluent phosphate standard was considered too stringent and resulted in costly chemical overdosage and unnecessary increases in effluent dissolved solids. In order to minimise cost and chemical overdosage it was found essential to optimise chemical addition by adopting an appropriate chemical dosing strategy.

Strategies

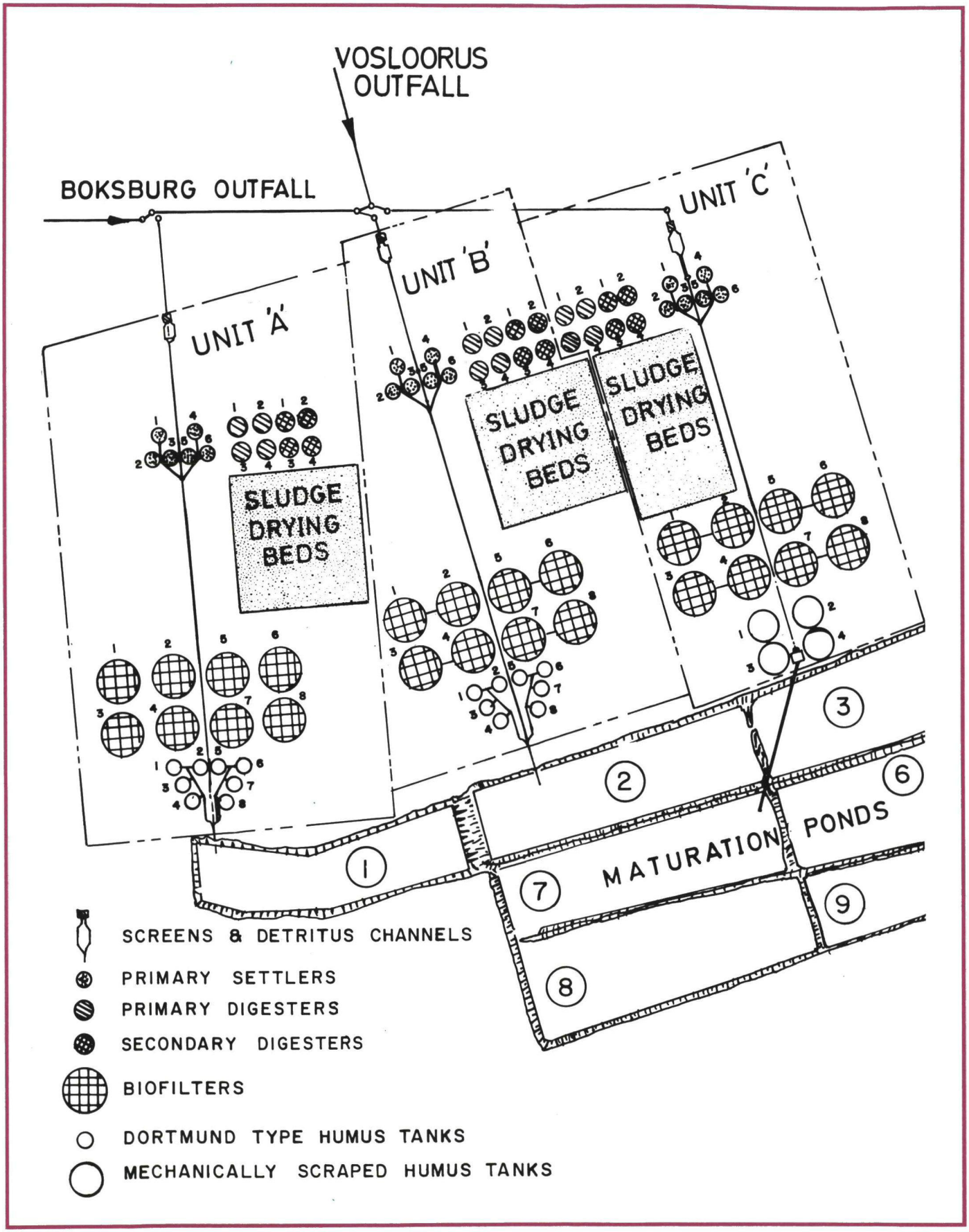
Three chemical dosing strategies were evaluated, viz. dosing proportional to flow with

- ☐ a constant ration for dosage rate to unit flow rate,
- ☐ an increased ratio for dosage rate to unit flow rate on Thursdays and Fridays, and
- ☐ dosage rate adjusted on a "day of the week four weekly moving average for phosphate concentration" strategy.

The latter was the most successful requiring 2,0 - 2,5 times the stoichiometric $FeCl_3$ P amount of $FeCl_3$ to be dosed, whereas the other strategies required 3,5 - 4,5 times the stoichiometric dosages.

The introduction of chemical phosphate removal at the Vlakplaats Works resulted in significantly increased masses of "humus" (biological/chemical) sludge. Provision had to be made for continuous sludge withdrawal from these humus tanks in order to ensure that no solids carry-over took place from these tanks. The increase in "humus" sludge mass had a negligible effect on the total sludge production of the plant. The physical characteristics of the mixed biological/chemical sludges did not significantly differ from conventional sludges and did not require any changes in terms of sludge drying or disposal.

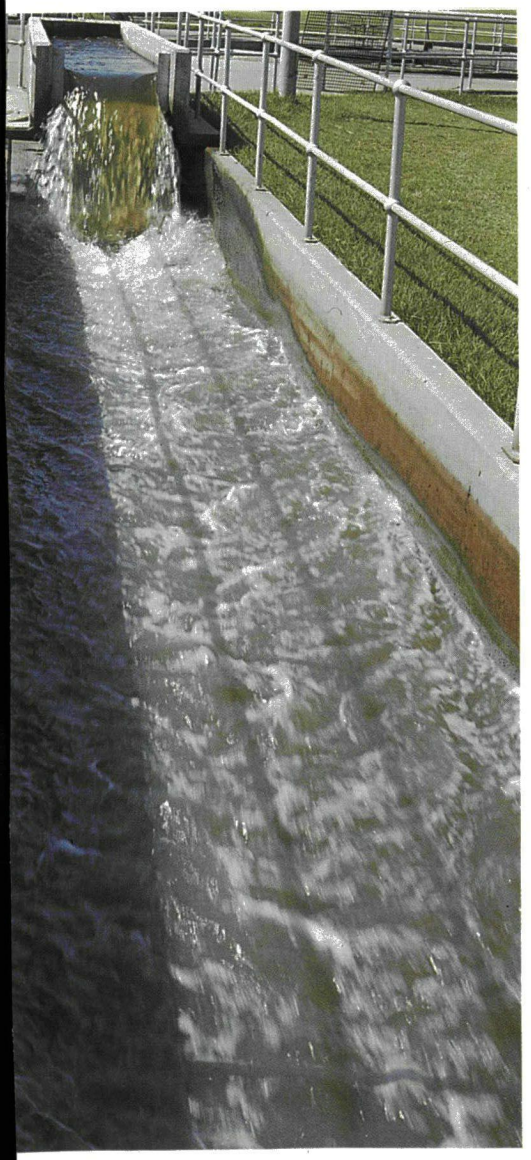
The highly corrosive nature of ferric chloride used for phosphate precipitation necessitated the use of corrosion resistant materials for its handling and pumping. Loss of alkalinity in the effluent dosed with ferric chloride had to be counter-acted by



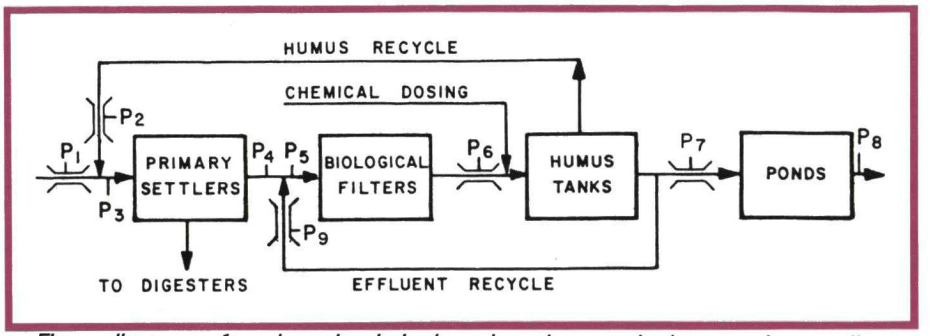
Layout of Boksburg's Vlakplaats works.

addition of lime to prevent the production of an effluent which could be aggressive to concrete structures and corrosive to steel pipes and pumps.

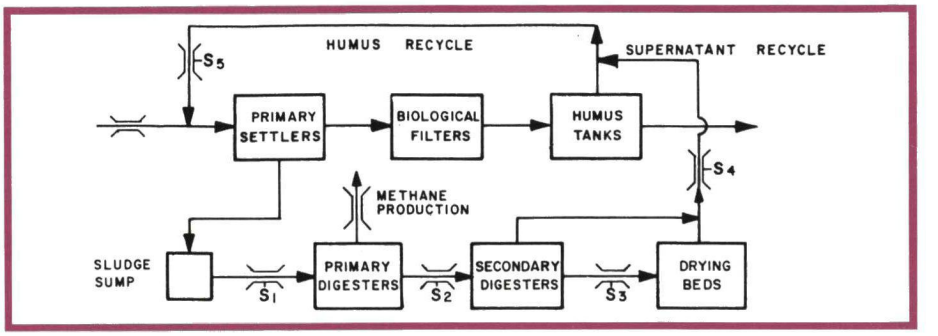
An investigation of the South African Bureau of Standards (SABS) analytical method for suspended solids demonstrated that this technique was not suitable for the determination of suspended solids at concentrations below about 50 mg/l, and particularly for the 20 mg/l as specified by The General Standard for effluents. Improved solids recovery was obtained when using Whatman GF/C or GF/D, or Rundfilter MN85/90, filter paper, although the recovery was still only 50 per cent.



Channel carrying biological filter effluent into which chemical is dosed.

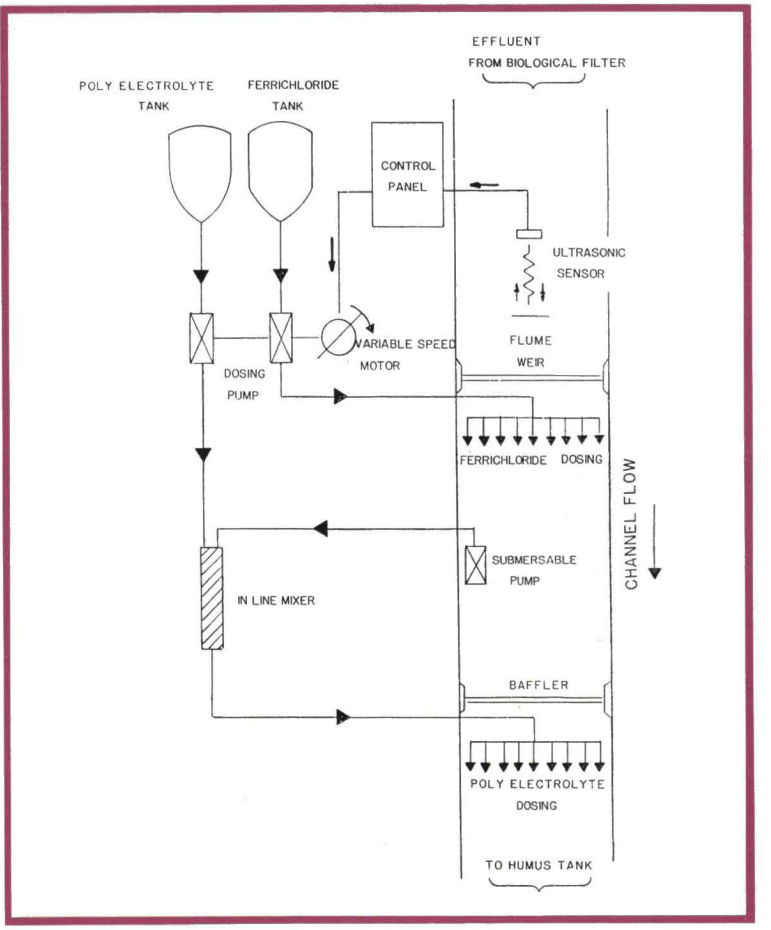


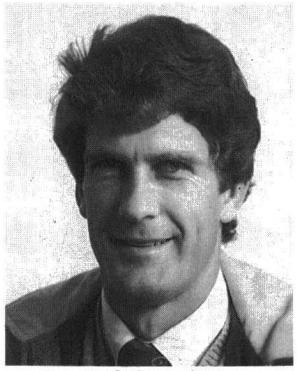
Flow diagram for chemical dosing showing metering and sampling points.



Flow diagram for sludge disposal showing metering and sampling points.

Diagram of the chemical dosing plant used at Vlakplaats.





Dr MC Dent, co-author of the report.

Natal study will help irrigation planners in South Africa

A research report entitled Crop water requirements, deficits and water yield for irrigation planning in Southern Africa by MC Dent, RE Schulze and GR Angus of the Department of Agricultural Engineering at the University of Natal has been released by the Water Research Commission.

The report summarises the final results of a project funded by the Water Research Commission on regional soil moisture deficit analysis for irrigation planning, and contains valuable information related to the estimation of crop water requirements under irrigated and dryland conditions. A map of Southern Africa depicting 712 homogeneous climate zones is also included in the report.

Copies of the report are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. To order please complete the post card in this Bulletin.

Much of Southern Africa's arable farming is carried out on land which, in terms of typical soil moisture content, can be described as marginal. Information on likely soil moisture status is therefore an invaluable tool to the agricultural planner in regard to supplementary irrigation and for dryland farming.

The practice of supplementary irrigation is increasing rapidly for several reasons:

- ☐ New crops are being introduced into areas which are climatically marginal.
- ☐ Development corporations in the National States are promoting total and supplementary irrigation schemes.
- ☐ Crop yields are boosted by supplementary irrigation and the practice is being used as a crop yield insurance measure.
- ☐ The production of crops under irrigation primarily for more intensive feeding of livestock is becoming an increasingly widespread phenomenon in parts of Southern Africa.

The recent drought of the late 1970s and early 1980s, coupled with the mounting demand for water has brought the need for water resources planning into focus. Agriculture accounts for approximately 52 per cent of the water consumed in South Africa and apart from the individual farmer's need to plan, it is necessary to estimate irrigation water requirements for potential development in whole regions. This is essential in order to ascertain how much water will remain for urban and industrial use.

PLANNING REQUIREMENTS

In Southern Africa the areas in which the major crops are being grown under dryland conditions, have in the past been determined by a number of factors of which the economic factor plays a dominant role. Climatological disadvantages have often been masked by economics which have enabled crops to be grown "profitably" in regions where they are unsuited climatically. Profitability, although understandably a dominant factor in decision making, is also an unreliable and fickle phenomenon which can alter very suddenly and a change in pricing structure of inputs, transport or products, may result in the need to seek alternative crops.

It is at exactly this time, when the need to find alternative crops is most pressing, that scientific research such as that contained in this report is so valuable.

However, a manageable solution to the problem of estimating monthly water requirements for supplementary irrigation and dryland crops is complicated by the numerous factors which interact to form the water demand. The requirement is primarily a function of the rainfall amount and frequency in association with evapotranspiration, soil type, crop type, time of planting, as well as the stage of growth of the crop and its rooting depth. An estimate of the probabilities of occurrence of these water requirements is also essential in risk management planning.

The agricultural planner is often faced with a large number of possible crop, soil and risk management options which must be considered. Comprehensive planning therefore requires appraisals of the many combinations of the aforementioned variables. The presentation of estimated irrigation or dryland crop water requirements for all possible combinations of these variables, can be very cumbersome. It was essential to reduce this volume of information for use by agricultural planners.

At present the standard text used by many planners of irrigation schemes is a publication entitled "Estimated irrigation requirements of crops in South Africa". In that publication a daily soil moisture budget approach was used to generate estimated irrigation requirements, at 118 climate stations in South Africa, for a range of crops, soils, planting times, irrigation cycle times and application amounts. By being so specific, this publication, despite its bulk, leaves the majority of possibilities unexplored and therefore does not always satisfy the planner's needs.

In Southern Africa few planners of irrigation schemes run their own daily soil moisture budgeting models in which daily climatic data and site specific crop, soil and planting time information are used. In many instances monthly mean rainfall and pan evaporation or some probabilistic value of monthly rainfall is used to obtain a coarse estimate of crop water requirements for planning purposes.

OBJECTIVES

This study had several objectives related to the estimation of crop water requirements under irrigated conditions. In addition the aspects of crop water requirements and runoff under dryland conditions formed a secondary objective were also investigated.

Some of the primary objectives were:

- ☐ to provide a detailed delimitation of zones throughout Southern Africa of more or less homogeneous climate and to provide estimates of crop water requirements under irrigated conditions in each zone;
- ☐ to reduce the bulk, whilst retaining the essential content, of information which is normally forthcoming from such an analysis involving a large number of combinations of possible input, i.e. crops, soils and planting dates;
- ☐ to provide an estimate of the frequency of non- exceedence of certain levels of irrigation requirement, based on analyses of soil moisture budgets using long daily rainfall records; and to verify the soil moisture budgeting models which were used to estimate the above information.

HOMOGENEOUS CLIMATE ZONES

Invariably the potential user of the information generated in this study will need to apply the information to sites other than that of the rainfall station used. To assist such users and to provide a rational way of selecting the required rainfall stations, the region surrounding the rainfall station and for which the selected rainfall/temperature station is considered representative, was delimited. To this end 712 homogeneous climate zones were identified and delimited in Southern Africa. A long term daily rainfall station was selected for each of these zones. This station then provided the daily rainfall input data for both the irrigation and dryland approaches.

NEW APPROACH

On examination of the problem of reduction of information, it became apparent that the variables can be divided into two categories viz. those which are specific to an area and those which are specific to a site. Whereas the high spatial variability of daily rainfall is appreciated, the location of existing long term raingauges means that rainfall has, for practical purposes, to be considered specific to or to pertain to a relatively large area. The so-called area- specific variables which were used in this study

M C DENT
R E SCHULZE
G R ANGUS

CROP WATER REQUIREMENTS, DEFICITS AND WATER YIELD FOR IRRIGATION PLANNING IN SOUTHERN AFRICA

Report to the
WATER RESEARCH COMMISSION
by the
DEPARTMENT OF AGRICULTURAL ENGINEERING
UNIVERSITY OF NATAL

WRC Report No. 118/1/88
ACRU Report No. 28

are daily rainfall and potential evaporation; and the site-specific variables are soil and crop type, time of planting, stage of growth and rooting depth. The planner is normally well informed as to the soil conditions at the sites as well as the other variables pertaining to the cropping scheme which is being considered, i.e. the site-specific variables. The planner also requires maximum flexibility of choice with respect to these site-specific variables so that a wide range of options may be considered.

A soil moisture budgeting model was developed to estimate the possible crop water requirements under irrigated conditions. In this model, which catered for daily rainfall interception, actual evapotranspiration, rooting depth and soil texture, the irrigation water was applied when the soil moisture reached 50 per cent of the plant available moisture (PAM). The monthly summations of such water applications and the change in soil moisture storage between the first and last day of the month constituted the crop water requirement from irrigation. These values, for the entire daily rainfall record at each station, were ranked and the 50, 80 and 90 percentile values were extracted. The results of these analyses are useful for estimating irrigation requirements and the risk attendant to planning for these potential requirements.

The results of this study include a map of Southern Africa on which the 712 homogeneous climate zones are depicted. For each of these zones four pages of computer printout were produced. These pages contain the results of the crop water requirements study for irrigated conditions and the crop water requirement deficit, runoff and an index of stress days for a range of crops, soils and planting dates, under dryland conditions.

Agriculture accounts for approximately 52 per cent of the water consumed in South Africa and it is often necessary to estimate irrigation requirements for potential development in whole regions.

SA WATERWETENSKAPLIKES BESOEK TAIWAN

Vyftien Suid-Afrikaanse waterwetenskaplikes en -ingenieurs het in November verlede jaar 'n simposium in Taipei bygewoon. Die simposium is gereël ingevolge 'n uitruilooreenkoms tussen die National Science Council van die Republiek van China en WNNR. Die tema van die simposium was ENVIRONMENTAL TECHNOLOGY maar die onderwerpe wat bespreek is, het uitsluitlik oor water gehandel. Elkeen van die Suid-Afrikaanse afvaardiging het 'n referaat gelewer. Na afloop van die simposium is daar op uitnodiging van die Chinese afvaardiging samesprekings gevoer en verskeie tegniese besoeke afgelê.

Een van die Waternavorsingskommissie se navorsingbestuurders, dr MJ Pieterse, was deel van die groep en vertel hier meer oor die besoek en gee enkele indrukke van die land.

Die Nagmark in Taipei.

Die Suid-Afrikaanse afvaardiging is op 'n uiters vriendelike wyse ontvang en onthaal en goeie kontakte is gemaak met die oog op toekomstige samewerking.

Dit was 'n openbaring om iets van die Chinese se tegnologiese vermoëns en kultuur te leer. Wat hulle in die Republiek van China (RVC) reggekry het, is voorwaar 'n "ekonomiese wonder".

In die proses van industrialisasie en ekonomiese vooruitgang is die omgewing egter verwaarloos maar hulle staan nou aan die begin van 'n nuwe era wat ook skouspelagtig kan wees ten opsigte van omgewingsopheffing. Hierin bestaan moontlikhede vir samewerking en benutting van plaaslike kundigheid.

Die ekonomiese wonderwerk van die RVC

Veranderings vind teen 'n ongekende tempo in die RVC plaas. Gedurende die jare vyftig het die regering besluit dat iets drasties aan die ekonomie gedoen moet word en die resultate van hierdie besluit is skouspelagtig. Enkele voorbeelde hiervan vir 1989 (in VSA-dollar):

- ☐ Per capita inkomste $5 000 (teenoor $50 in 1950)
- ☐ Per capita bruto nasionale produk $3 700
- ☐ Ekonomiese groeikoers 10,81 persent
- ☐ Internasionale handel $88 x 10^9 (dertiende in die wêreld)
- ☐ Buitelandse beleggings $77 x$10^9$ (derde in die wêreld)

Hierdie ekonomiese sukses is in 'n groot mate te wyte aan die veranderings en hervormings wat ingestel is vir die bevordering van 'n politieke demokrasie, 'n liberale ekonomie en sosiale pluralisme.

In die vyftigerjare het die klem in die RVC veral op voedsel, tekstiele en boumateriale geval; in die sestigs op petrochemikalieë en elektriese toebehore; in die sewentigs op petrochemiese tussenstowwe en swaar nywerhede; in die tagtigerjare op elektronika, masjiene en outomatisasie; en in die negentigs sal die fokus op inligtingstelsels wees.

Gedurende die periode van snel ekonomiese groei en nywerheidsontwikkeling het omgewingsbewaring egter in 'n groot mate agterweë gebly.

Voor: dr Thys Pieterse (WNK), prof Chris Buckley (Universiteit van Natal), mnr Hendrik Best (Departement van Waterwese) en mnr Japie Schoeman (Divisie vir Watertegnologie).

Middel: mnr Gerrit Botha (SS&O), mnr Kobus du Toit (Sasol), dr Daan Toerien (Divisie vir Watertegnologie, leier van groep) en dr Peter Ashton (Divisie vir Watertegnologie).

Agter: dr Dirk Grobler (Departement van Waterwese), mnr Schalk van der Merwe (Randwaterraad), prof George Ekama (Universiteit van Kaapstad), mnr Bill Ross (Divisie vir Watertegnologie), mnr Piet Meiring (Meiring en Barnard), dr Henk van Vliet (Departement van Waterwese) en dr Piet Aucamp (Departement van Nasionale Gesondheid en Bevolkingsontwikkeling).

Huidige water-besoedelingsprobleme

Die RVC het te kampe met ernstige waterbesoedelingsprobleme.

Daar is 21 belangrike riviere in die RVC en volgens 'n opname in 1987 was 30 persent van die totale lengte van die riviere besoedel en 13,5 persent ernstig besoedel. (Die graad van besoedeling word volgens 'n plaaslike indeks bepaal en parameters soos opgeloste suurstof, biologiese suurstofbehoefte, gesuspendeerde stowwe en ammoniakstikstof, word gebruik).

Wat die besoedelingslas betref is 54 persent van nywerhede afkomstig, 25 persent van munisipale afvalwater en 21 persent van veeboerdery.

Daar moet besef word dat die RVC 'n hoë bevolkingsdigtheid het, naamlik 1 500 per km^2 met 'n totale bevolking van 24,5 miljoen.

Die besoedelingsprobleem word in perspektief gestel as besef word dat net 13,3 persent van die huishoudings in Taipei (hoofstad van die RVC) toegang tot 'n sentrale rioleringstelsel het en vir die land as geheel is hierdie syfer minder as 1 persent.

'n Verdere bydraende faktor tot besoedeling is dat daar 7,18 miljoen varke op die eiland is en daar word beraam dat een vark 'n besoedelingslas veroorsaak wat ekwivalent is aan 7 persone. 'n Verdere besoedelingslas kom van die 70 miljoen hoenders in die RVC.

Daar word ook probleme met besoedeling van ondergrondse water ondervind. So byvoorbeeld het een derde van alle boorgate en fonteine yster- en mangaankonsentrasies wat hoër is as die drinkwaterstandaard.

Probleme word ook met seebesoedeling ondervind, veral deur swaarmetale.

Bekamping van waterbesoedeling

In die lig van die waterbesoedelingsprobleme het die regering in die RVC op 'n omvattende en indrukwekkende program vir die bekamping daarvan besluit. Dit is onmoontlik om hier reg aan die program te laat geskied, maar enkele hoogtepunte is die volgende:

- ☐ Hersiening van bestaande en daarstelling van nuwe wette, regulasies en kwaliteitstandaarde.
- ☐ Die skoonmaak- en opgraderingsproses van spesifieke riviere en mere.
- ☐ Die ingebruikstelling van afvalwaterbehandelingsprosesse.
- ☐ Inwerkingstelling van projekte om seebesoedeling te bekamp.
- ☐ Spesifieke aksies om 'n goeie drinkwatergehalte te verseker.
- ☐ Beheer oor grondwateronttrekking.
- ☐ Beheer van septiese tenksanitasie.
- ☐ Bevordering van die konstruksie van rioleringstelsels.
- ☐ Opleiding van persone in verband met waterbesoedelingsbeheer en veiligheid van drinkwatervoorsiening.

Vir bogenoemde program is kort-, medium- en langtermynperiodes in die vooruitsig gestel. 'n Voorbeeld van 'n korttermyndoelstelling is dat voor 1991 alle nywerheidsafvalwater aan die huidige uitvloeiselstandaarde moet voldoen. Dit sal beteken dat die totale besoedelingslas met 24 persent verminder sal word.

Hierdie omvattende program is ontwikkel nadat heelwat reorganisasie plaasgevind het en die Environmental Protection Administration (EPA) in die lewe geroep is.

Environmental Protection Agency (EPA)
Die EPA is in 1987 as 'n organisasie op kabinetsvlak gestig. Die EPA is oorhoofs verantwoordelik vir die ontwikkeling van wetgewende voorstelle en die implementering van nasionale wette vir omgewingsbewaring. Die beleid en beginsels van die EPA kan kortliks as volg opgesom word:

- ☐ Ekonomiese ontwikkeling en omgewingsbewaring sal ewe veel gewig dra; indien ekonomiese ontwikkeling die omgewing besoedel, sal omgewingsbewaring 'n hoër prioriteit geniet.

  'n Deeglike plan vir voorkoming van besoedeling moet altyd van krag wees.
- ☐ Suksesvolle samewerking tussen regering, nywerhede, universiteite, spesialiste en publiek moet bewerkstellig word.
- ☐ Die publiek se rol in bekamping van omgewingsbesoedeling moet verhoog word.
- ☐ Besoedelaars moet die koste betaal.

  Stelsels sal ontwikkel word vir die
- ☐ taksering van die impak op die omgewing, geskilbeslegting, EPA-wetgewing en vir 'n nasionale moniteringsnetwerk.
- ☐ Nasionale projekte in verband met omgewingsbewaring sal ontwikkel word.

Die gebiede wat deur die EPA gedek word, is die volgende: lugbesoedeling, geraas, waterbesoedeling, toksiese stowwe, vullis en afval, en gevaarlike afval.

EPA beraam dat sy besteding aan omgewingsbewaring teen die jaar 2000 in die orde van R100 miljard sal wees.

In die woorde van dr Eugene Chien, direkteur-generaal van die EPA: " If you want a clean life, you must pay some dues. There is never something for nothing".

Afvalwaterbehandeling

Die besoeke het ook twee afvalwaterbehandelingswerke ingesluit. Die een behandel die Science-based Industrial Park se afvalwater wat uit 25 persent huishoudelike afvalwater en 75 persent nywerheidswater bestaan. Hierdie aanleg is maar pas in bedryf gestel. (Die Science-based Industrial Park is 'n baie interessante ontwikkeling om hoë-tegnologie te betrek en te ontwikkel).

Die ander aanleg behandel afvalwater van die stad Kaohsiung (1,3 miljoen inwoners) voordat dit na die Love-rivier gaan. Voorheen het die afvalwater direk na die rivier gegaan. Sedert die ingebruikneming van die aanleg in Januarie 1987 het daar 'n merkwaardige verbetering in die estetiese waarde en gehalte van die water in die Love-rivier ingetree.

'n Toneel in die Taroko Nasionale Park wat deur die afvaardigers besoek is.

Die RVC staan egter aan die begin van 'n era wat afvalwaterbehandeling betref.

Drinkwatervoorsiening

Ongeveer 80 persent van die huishoudings in die RVC ontvang water vanaf munisipale waterbehandelingswerke, terwyl die res ondergrondse water as drinkwater gebruik.

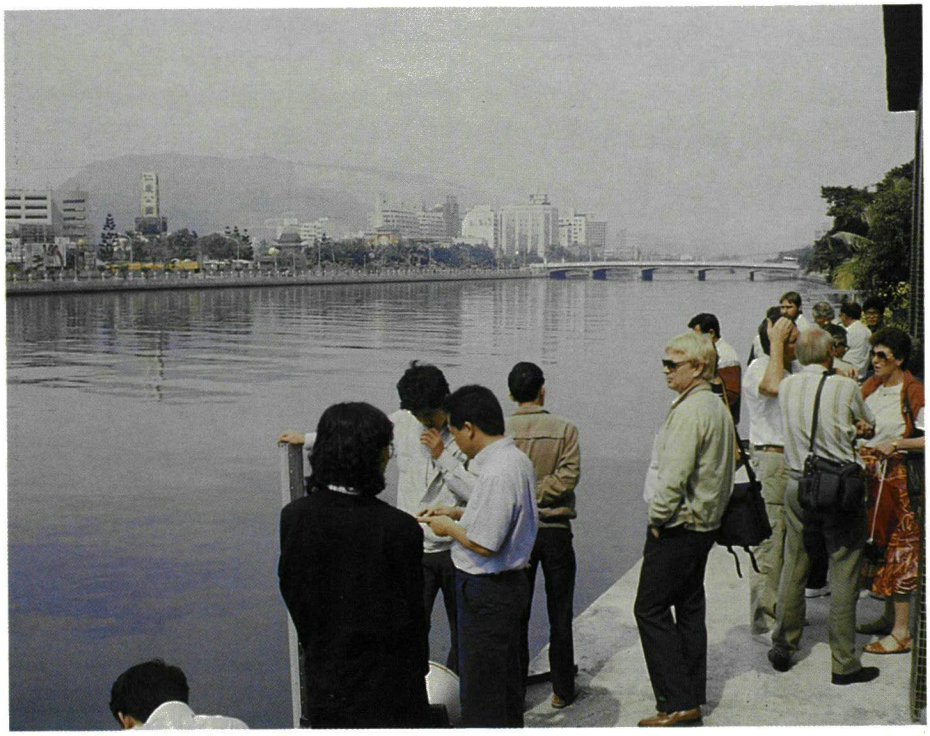
Die Feitsui Reservoir naby Taipei is in Junie 1987 voltooi. Dit verskaf water aan groter Taipei (ongeveer 4,6 miljoen mense) en het 'n opbergingskapasiteit van 406 x 106m^3. Dit behoort tot die jaar 2030 aan die behoeftes van groter Taipei te voorsien.

Verdere kontak

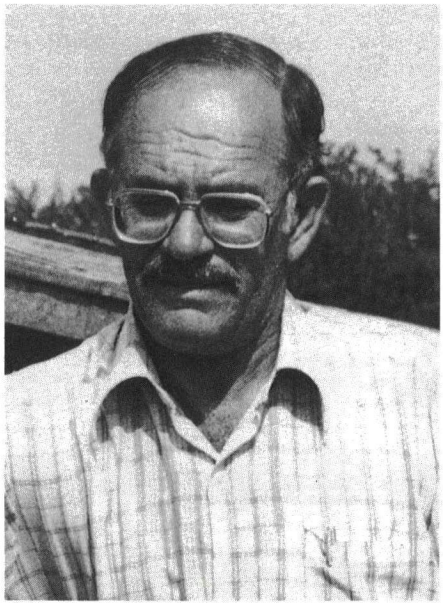
Aan die einde van die besoek het die Suid-Afrikaanse afvaardiging spesifieke geleenthede geskep waartydens indringend oor die besoek en oor toekomstige optrede besin is.

Die Suid-Afrikaanse afvaardiging het, ondere andere, besluit om 'n studiegroep te stig wat as kern kan dien vir toekomstige interaksie met waterwetenskaplikes en -ingenieurs in die RVC. Een van die take wat vir die studiegroep in die vooruitgang gestel is, is om 'n databasis van RVC-kundigheid in die waterveld te ontwikkel.

Daar bestaan tans 'n ooreenkoms tussen die NSC en WNNR, ingevolge waarvan nagraadse studente uitgeruil kan word. Daar is egter gevoel dat die uitruil van ander wetenskaplikes ook bevorder moet word. 'n Interessante punt wat ook genoem is, is dat die uitruil van besoedelingsbeheerbeamptes en selfs konsultante oorweeg kan word.



Die Love-rivier in die stad Kaohsiung. Ingevolge die nuwe omgewingsmaatreëls is die watergehalte van hierdie rivier aansienlik verbeter.



Lombaard span uit

Mnr HC (Hennie) Lombaard, Direkteur: Administrasie van die Waternavorsingskommissie en lid van die WNK se hoofbestuur het op 1 April vanjaar met pensioen afgetree.

Mnr Lombaard wat ook direkteur was van MANATWA, die Maatskappy vir Navorsing oor Atmosferiese Waternavorsing, het in 1974 by die Waternavorsingskommissie as algemene administratiewe sekretaris diens aanvaar. Hy was voorheen vir meer as twintig jaar aan die Transvaalse Provinsiale Administrasie verbonde.

Mnr Lombaard is op 9 Februarie 1929 in die distrik Barkley- Wes gebore. Hy matrikuleer in 1947 aan die Hoërskool Vaalharts en verwerf met deeltydse studie in 1963 'n BA graad in administrasie aan die Universiteit van Pretoria.

Hy is in Oktober 1955 getroud met Martie Pieterse en twee seuns en 'n dogter is uit die huwelik gebore.

Mnr Lombaard beplan om hom voortaan voltyds aan sy uitgebreide boerderybelange toe te wy.

South African engineer awarded US medal

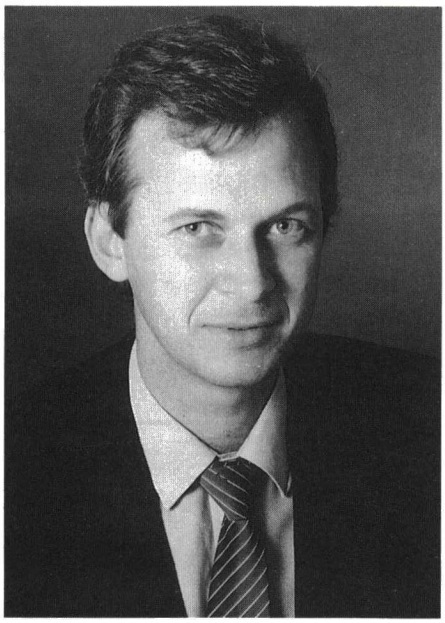
A Johannesburg engineer has been awarded a medal for research that makes a valuable contribution to existing knowledge of the fundamental principles and processes governing wastewater treatment.

The recipient is Dr Andre van Niekerk, partner of the firm Wates and Wagner, Consulting Engineers, who specialise in water, solid waste and geotechnical engineering.

Dr van Niekerk and his co-workers were selected by the USA Water Pollution Control Federation to receive the Harrison Prescott Eddy Medal on the basis of their research into the control of filamentous bacterial growth in wastewater treatment plant. The Federation selects candidates annually to receive awards for their contributions to the internationally important studies covering water pollution control.

Dr van Niekerk, who recently obtained a Ph.D degree at University of California, Berkeley, had his scientific paper on the subject published in the journal of the USA Water Pollution Control Federation. His research addresses a problem often found in sewage treatment plants, both here and abroad.

Appropriate application of the control technology will limit bulking in activated sludge plants and could lead to substantial capital savings in sewerage plants and also limit the risk of environmental pollution.

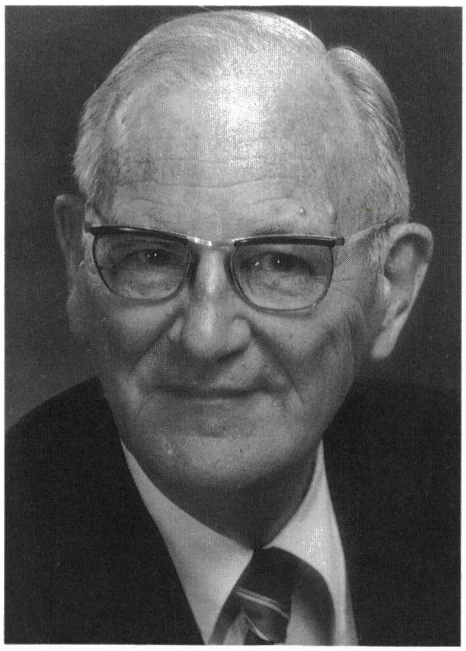


Stutterheim awarded

Dr Nico Stutterheim, member of the Water Research Commission, has recently been awarded the 1989 Federation of Societies of Professional Engineer's (FSPE) award for service to the engineering profession.

Gold for Kriel

Dr JP Kriel, Chairman of the Water Research Commission, recently received the South African Institution of Civil Engineers' Gold Medal for outstanding services to the Institution and the Civil Engineering profession.



WISA AND WRC HOLD WORKSHOP ON WATER SUPPLY NETWORKS

The Water Institute of Southern Africa (WISA) in association with the Water Research Commission (WRC) has arranged a one day workshop to discuss matters of common concern relating to the management and analysis of water supply networks. The feasibility of establishing a WISA Technical Division on Water Distribution Management will also be discussed.

Venue:

Date: Wednesday, 30th August 1989

Time: 09h00

Fee: R50,00 per person includes teas and lunch

Cocktails will be served at the conclusion of the workshop

Topics of invited Speakers are:

Prof J Gessler: Guest Speaker Colorado State University

Mr D Behrmann: The Practical Application of the Use of Network Analysis Models. (de Leuw Cather)

Dr BF Loubser: Optimal Pipe Sizing for Extensions to Existing Networks. (Geustyn, Forsyth and Joubert)

Mr S Verrier: Analysis and Management of a water Reticulation System. (Johannesburg Water and Gas Department)

Dr CA Constantinides: Analysis, Design and Planning of Water Supply Systems - a comprehensive approach. (Hydraulic Computer Services)

Mr P Dally: Application of a Real Time Network Simulation Programme to Durban's Trunk Main System.

Mr Z Szecsei: Data capture for network applications in GIS (Geograph (Pty) Ltd)

Chairman for the meeting will be Mr Eric Hall.

For further information please contact either Mr E Hall (011) 403-3731 or Mr HC Chapman (012) 330-0340

Reservations together with payment can be made before August 25, 1989, to:

Miss Helene Joubert
Water Research Commission
PO Box 824
PRETORIA
0001
RSA

WATSNU database for domestic water supplies and sanitation in KwaZulu

A computerized literature survey database of written material relating specifically to domestic water supplies and sanitation in KwaZulu (excluding irrigation) is now available (w.e.f. February 1989). Aspects of the earlier water resources drought (including the outbreak of cholera) as well as floods in KwaZulu are also covered. Since the literature is "youthful" special emphasis was placed on the listing of "grey literature" namely, unpublished reports, theses, etc. The project developed by the Department of Economics at the University of Natal, Pietermaritzburg is known as the WATSNU (Water and Sanitation - Natal University) literature database. The print-out of all references is available at a cost of R20. Cheques or postal orders should be made payable to the University of Natal. Please note that WATSNU cannot supply copies of the listed references and readers should contact the relevant organization directly for copies. Addresses where necessary, are provided in the print-out.

The database will be of interest to anyone working in the field of black rural, peri-urban or urban water supplies. It is hoped that the development of a water literature database for KwaZulu will encourage other organizations to initiate regional literature files on given topics so that information for several black areas becomes readily available. It should be noted that it is not the intention of the compiler of WATSNU to compete with the WATERLIT system operated by CSIR, but rather to cover material not listed by WATERLIT. General hydrological or geographical information, of which KwaZulu forms a part, can be obtained from WATERLIT. Similarly, medical literature relating to water diseases in general, can be derived through the SAMED system run by the Medical Research Council.

Further details of the WATSNU file can be obtained from:

The Secretary
Department of Economics
University of Natal, PO Box 375,
Pietermaritzburg 3200.
Telephone number: (0331) 63320 during office hours.

New titleS

From Elsevier Science Publishers

PO Box 211, 1000 AE Amsterdam, The Netherlands

Agrohydrology - recent developments

Proceedings of the Symposium Agrohydrology at the International Agricultural Centre IAC, Wageningen, The Netherlands, 29 September - 1 October 1987 edited by JW van Hoorn, Department of Land and Water Use, Agricultural University, Wageningen, The Netherlands.

550 pages. 144.75 US dollars.

Groundwater discharge tests: simulation and analysis.

by D Clarke, Crystal Brook, SA, Australia.

384 pages. 94.75 US dollars.

Groundwater modelling - an introduction with sample programs in BASIC.

by W Kinzelbach

334 pages. 76.25 US dollars.

Microcomputer programs for groundwater studies.

by D Clarke

268 pages. 76.25 US dollars.

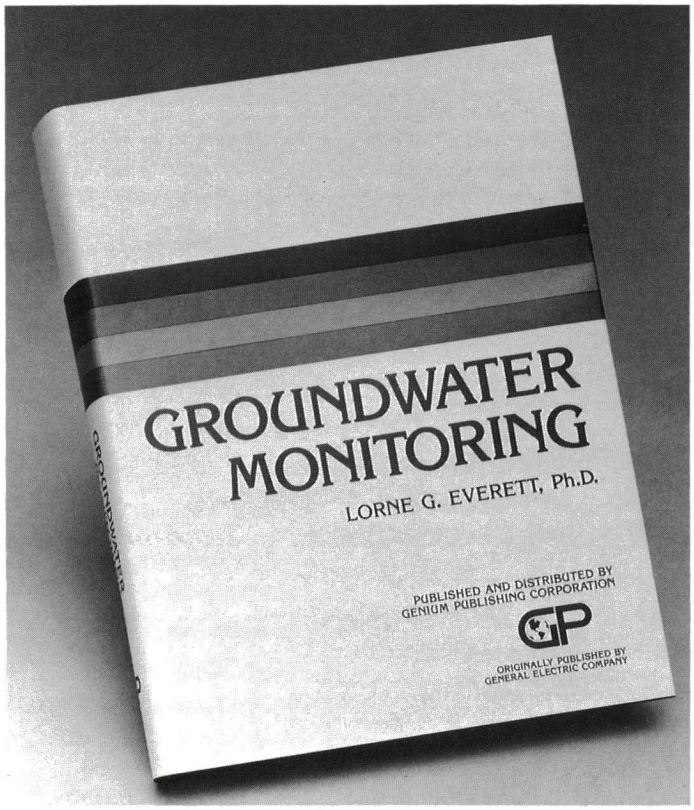
From VCH Verlagsgesellschaft, Pappelalee 3, D-6940, Federal Republic of Germany.

Laboratory manual for the examination of, water, waste water and soil.

by H Rump and H Krist

190 pages with 47 figures and 45 tables.

20.25 pound sterling.



This 440-page volume supports each monitoring technique with numerous figures and tables to permit evaluation of the various methods available and to enable the user to make rapid, cost-effective decisions.

1988: 440 pages.

Price: 185 US dollars

ISBN: 0 931690 14 5

Available from Genium Publishing Corporation, Room 214, 1145 Catalyn Street, Schenectady, NY 12303-1836 USA.

Groundwater monitoring

by Dr Lorne G Everett

A handbook for the evaluation, design and implementation of groundwater monitoring programs.

This book describes a cost-effective, generic methodology for monitoring the quality of groundwater. This methodology was developed by a team of eminent hydrologists working on a million dollar government study and has been selected by the US Environmental Protection Agency as the basis for their monitoring guidelines for coal strip mining sites and oil shale tracts. The techniques presented can be applied either at a particular site or on a regional basis. They are proven, effective approaches that can be implemented now, saving much of the time and cost involved in developing a monitoring system.

The handbook provides a comprehensive description of the methodology, including the needs, objectives, and constraints of such a program. The constituents of groundwater pollution are discussed, as well as the sources and causes of such pollutants. A description of monitoring techniques used in topsoil, the vadose zone, and the saturated zone are provided.

Agricultural and forest meteorology

An international journal

Agricultural and Forest Meteorology is an international journal for the publication of articles and reviews in the interdisciplinary fields of meteorology and climatology applied to agriculture and forestry. Emphasis is on basic and applied scientific research and the application of this research to practical problems in agriculture and forestry. Theoretical models should always be tested against experimental data. Typical topics include radiation transfer in plant canopies, evapotranspiration, energy transfer, air movement and turbulance in and above plant canopies, forest-fire/weather interactions, climatology of plant distribution, phenology, glasshouse energy balance and climate, climate/growth relationships, and other topics in plant and animal biometeorology. Special issues devoted to single topics, conference proceedings and comprehensive reviews are also published.

Free sample copy available from Elsevier Science Publishers

Attention R Hayward, PO Box 330, 1000 AH Amsterdam, The Netherlands

Agricultural water management

An international journal

The journal is concerned with the publication of scientific papers of international significance to the management of agricultural water. The scope includes such diverse aspects as irrigation and drainage of cultivated areas, collection and storage of precipitation water in relation to soil properties and vegetation cover, the role of ground and surface water in nutrient cycling, water balance problems, exploitation and protection of water resources, control of flooding, erosion and desert creep, water quality and pollution both by, and of, agricultural water, effects of land uses on water resources, water for recreation in rural areas, and economic and legal aspects of water use. Basic soil-water-plant relationships will be considered only as far as is relevant to agricultural water management.

Free sample copy available from Elsevier Science Publishers

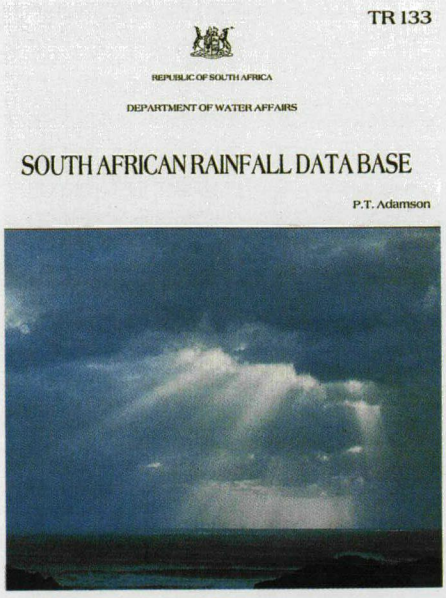
Attention R Hayward, PO Box 330, 1000 AH Amsterdam, The Netherlands.

South African rainfall data base

by PT Adamson

This publication considers the long established problem of conveniently assessing South African rainfall data. To date the methods available to most users of the data have been anything but convenient, since those organisations with suitable computing facilities have still had to search up to 14 tapes for the required data. Other users have been provided with printouts, which are neither a convenient nor an efficient means of data dissemination.

Once the data are to hand there remains the formidable task of estimating the inevitable missing values. Usually, missing or incomplete monthly totals are estimated using some or other model, or data at some control station substituted for the missing value. Most of these established methods are inefficient to a degree, not least from the statistical viewpoint. Of equal concern is the fact that, unless missing data are estimated on a daily basis, then it is impossible to take account of the various types of gap that can occur. Ignoring, for example,



the coding system adopted (by the Weather Bureau) for missing data leads to the rejection of a considerable amount of valuable information. Finally, there is an obvious need to standardise the means of gap filling.

The report emphasises hydrological applications of rainfall data, but is also addressed to a wider audience, most notably those in the climatological and agricultural sciences.

Since the exercise in gap-filling is the major original contribution contained in this report, it is dealt with in extensive detail. Thus Part II contains a full description of the algorithm and a full guide to the program listing (Appendix I). Step by step illustrations of how to go about estimating missing data at a given station are provided along with practical examples. The file names used are purely incidental and refer to those on the Departmental machine. A guide to file names is provided at the beginning of the report. Other users of database OPTION 1 are provided with all programs contained within this report and can, given the usual alterations required by their compilers, carry out the gap-filling in exactly the same way.

Part III is largely aimed at Departmental (Water Affairs) users, although any user (e.g. Agriculture, Environment Affairs) with direct access to the Database can set up their job files in exactly the same way. Since the database and masterprograms are contained on a private and dedicated disc pack, Part III is intended to illustrate access from other packs (e.g. WPAK1) for the purposes of gap-filling and data abstraction. The emphasis is thus on the creating of job- files for inclusion in a user's own library of files. Some illustrative applications are included to the end of encouraging inventive data analysis.

Part IV is directed at other users taking up either of the database options. It is largely concerned with the file specifications required for loading the database and program files to other machines. Given that this is achieved all other files for the analysis and accessing of data can be used and in precisely the same manner as detailed in Part III.

Part V is included for the sake of completedness and provides details and examples of how to simulate daily (and thus weekly, monthly, etc.) sequences of rainfall at any one of the 2 500 sites given in Appendix 16. This material is based on the work of Zucchini & Adamson (1984) and examples of how to combine simulated and historical sequences in data analysis are provided.

Available from the Department of Water Affairs, Private Bag X313, Pretoria 0001.

Tyson publishes best science book

Professor Peter Tyson, Vice-Principal of the University of the Witwatersrand and Director of the Climatology Research Group, has received a joint award of the prestigious 1988 Bill Venter Award for the best book published over the four-year period 1983-86 in the natural sciences.

Internationally recognised as an authority on climatic change, Professor Tyson's book "Climatic Change and Variability in Southern Africa" has received worldwide recognition. Described as a "user's book, it addresses the subject of climate, past, present and future, and examines climatic change over three thousand million years, emphasising variations in rainfall over the period of the meteorological record.

SAGIS

An international conference and workshop on geographic information systems will be held at the University of Natal, Pietermaritzburg, from 3 to 6 July 1989.

Enquiries: Dr RJ Fincham, Institute of National Resources, P O Box 375, Pietermaritzburg 3200, RSA.

WATER LAW

A mini-symposium on water: laws and management, will be held on 7 July 1989 at the University of Cape Town.

Enquiries: Dr JA Thornton, Town Planning Branch, P O Box 1694, Cape Town 8000, RSA.

GROUNDWATER

Groundwater '89, the 5th biennial symposium of the Ground Water Division of the Geological Society of South Africa will be held from 31 July to 5 August 1989 in Johannesburg. The theme will be "Groundwater and mining".

Enquiries: The Symposium Secretary, Groundwater '89, P O Box 8856, Johannesburg 2000, RSA.

ANAEROBIC DIGESTION

A symposium to discuss laboratory, pilot and full-scale experiences, current developments and research trends on processes will be held from 18 to 20 September 1989 in Bloemfontein, South Africa.

Enquiries: Mr Rhyno Kriek, Division for Non-Formal Education, P O Box 4345, Bloemfontein 9300, South Africa. Tel: (051) 4012425.

WASTE MANAGEMENT

The Transvaal Branch of the Institute of Waste Management (IWM) will be holding a branch seminar from 27 to 28 September 1989 at the World Trade Centre, Kempton Park. Subject areas will include: waste collection, waste disposal and hazardous waste.

Enquiries: IWM Seminar Committee, PO Box 1162, Bedfordview 2008, RSA. Telephone: (011) 514949 (Danie Joubert)

SANCIAHS

The 4th South African national hydrological symposium will be held in Pretoria from 20 to 22 November 1989.

Enquiries: Mr Stefan Kienzle, Department of Water Affairs, Hydrological Research Institute, Private Bag X313, Pretoria 0001, RSA. Tel: (012) 821100 x 207.

ANALYTICA '90

The first national symposium on analytical science - Analytica 90 - will be held from 18 to 23 March 1990 in Pretoria. The theme will be: Analytical technology in a developing South Africa. Call for papers.

Enquiries: The Chairman, Analytica '90, Department of Chemistry, University of Pretora, Pretoria 0002, RSA. Telephone: (012) 4202515.

RIVER BASINS

The 5th river basin management conference will be held in Rovaniemi, Finland, from 31 July to 4 August 1989.

Enquiries: The Secretary, Ms Anja Holmsten, P O Box 250, SF- 00101 Helsinki, Finland.

WASTEWATER TREATMENT

A symposium on the upgrading of wastewater treatment plants will be held in Munich, FRG, in August/September 1989.

Enquiries: Dr C-H Plumer, EWPCA, Markt 71, D-5205 Sankt Augustin 1, Federal Republic of Germany.

DRAINAGE

The 28th international post-graduate course on land drainage will be held from 20 August to 1 December 1989 in Wageningen, the Netherlands.

Enquiries: The Director of the International Agricultural Centre, P O Box 88, 6700 AB Wageningen, the Netherlands.

ACID RAIN

A symposium on acid rain will be held from 5 to 7 September 1989 in Amsterdam, the Netherlands.

Enquiries: Prof R Perry, Public Health and Water Resources Engineering, Department of Civil Engineering, Imperial College, London SW7 2 BU, UK.

REMOTE SENSING

The 7th thematic conference on remote sensing for exploration geology will be held from 2 to 6 October 1989 in Calgary, Alberta, Canada. The conference will include sessions on photogeology, engineering, environmental applications and hydrology.

Enquiries: ERIM/Thematic Conferences, PO Box 8618, Ann Arbor, Michigan 48107-8618, USA.

HYDRO POWERPLANTS

A conference on the upgrading and refurbishing of hydro powerplants will be held in Zürich, Switzerland from 16 to 18 October 1989. Themes include equipment (turbines, generators, governors and transmission) and civil works (dams, reservoirs, spillways, penstocks, gateworks).

Enquiries: Carolyn Price-Alexander, Water Power and Dam Construction, Quadrant, Sutton, Surrey SM2 5 AS, UK.

WATER POLLUTION

The WPCF Asia/Pacific Rim conference on water pollution control will be held from 22 to 25 October 1989 in Honolulu, Hawaii, USA.

Enquiries: David Bills, 119 Merchant Street, Suite 607, Honolulu, Hawaii 96813, USA.

INDUSTRIAL WASTEWATERS

The first IAWPRC Eastern Africa Regional Conference - Industrial wastewaters '89 - will be held in Nairobi, Kenya, from 25 to 28 October 1989. Sessions on policy and legislation, sources and effects, control methods, rehabilitation and upgrading processes and plant O/M.

Enquiries: Secretary, Scientific programme committee, Tampere University of Technology, PO Box 527, SF-33101, Finland.

GROUNDWATER MODELLING

An international conference on calibration and reliability in groundwater modelling will be held in the Netherlands from 3 to 6 September 1990.

Enquiries: Modelcare 90, PO Box 30424, 2500 GK The Hague, the Netherlands.

WATER SUPPLY

An international conference and exhibition on water supply and treatment: World Water '89 Congress, will be held from 14 to 16 November 1989 in London, UK.

Enquiries: Institution of Civil Engineers, 1 Great George Street, London SW 1 P 3 AA, UK.

THE SOUTH AFRICAN
CHEMICAL INSTITUTE

Northern Transvaal Section,
ChromSA, SAAMS

FIRST NATIONAL
SYMPOSIUM ON
ANALYTICAL SCIENCE

ANALYTICA '90

March 18 - 23, 1990

Pretoria

THEME

ANALYTICAL TECHNOLOGY IN A DEVELOPING SOUTH AFRICA

AIM

The Symposium aims to bring together all people concerned with analytical science.

SCIENTIFIC PROGRAMME

The programme will cover both theoretical and applied aspects of analytical science and will be organised around plenary, invited and contributed papers, which will include both oral and poster presentations.

EXHIBITIONS

The latest analytical equipment will be exhibited throughout the symposium. Any enquiries can be directed to:
Dr M Booth, Research and Development, AECI,
PO Modderfontein 1645,
South Africa.
Tel No: (011)6052316.
Telefax: 608-2540.

ACCOMMODATION

Delegates will be responsible for their own travel and accommodation arrangements.
A list of hotels will be supplied.

CALL FOR PAPERS

Participants are invited to submit papers to be included in the scientific programme. A booklet containing the abstracts of all papers will be made available to delegates at the Symposium.

Those who wish to attend Analytica '90 are kindly requested to complete the provisional registration post card in this Bulletin and return it not later than FRIDAY 30 JUNE 1989.

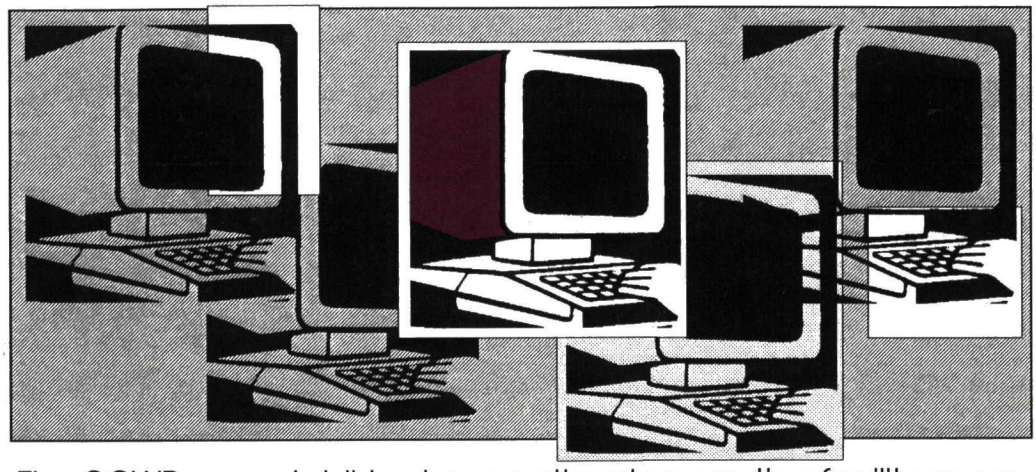
ADDRESS FOR CORRESPONDENCE

The Chairman
Analytica '90
Department of Chemistry
University of Pretoria
PRETORIA
0002,
South Africa

Telephone: (012)4202515
(Prof JF van Staden)
Telex: 3-22723 SA
Telefax: (012) 342 2453

C·C·W·R
Computing Centre for Water Research

A technology transfer agent to help South African water researchers communicate and share information, data and programs.



The CCWR was established as a national computing facility accessible to all water researchers and scientific consultants in South Africa.

The CCWR can:

- ☐ Give you access to the computer networks, UNINET and CSIRNET
- ☐ Supply you with specialised computer software
- ☐ Provide computing specialists to help solve your water research problems
- ☐ Provide daily or monthly rainfall data from over 9 000 weather stations
- ☐ Supply a variety of research results, information and data
- ☐ Provide an electronic mail connection to fellow CCWR users countrywide
- ☐ Effect file transfers between users
- ☐ Provide indirect access to the hydrological information system (HIS) at the Department of Water Affairs
- ☐ Provide the opportunity to conduct joint computer based research with colleagues at other institutions around the country
- ☐ The CCWR also provides research results, information and data to scientific consultants on a variety of electronic media.
- ☐ A small handling fee is charged.

For further information contact the Computing Centre for Water Research, c/o University of Natal, P O Box 375, Pietermaritzburg, 3200. Telephone number (0331) 63-320 ext 177/178. Fax number : 61 896