

S4 waterbulletin

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GROUNDWATER

Researchers report on salt balance of the Vaalharts Irrigation Scheme

WATER TREATMENT

Package water treatment plants evaluated for rural use

MINE WATER

Neutralising acid mine water with limestone - underground

00020088

UNESCO REGIONAL WORKSHOP

on

WOMEN'S PARTICIPATION IN WATER MANAGEMENT

24 - 26 November 1997
Pretoria, South Africa

This workshop is being organised by:

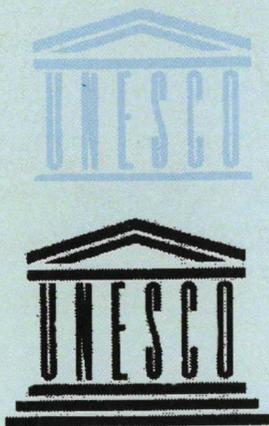
- UNESCO's International Hydrological Programme (IHP) together with
- the South African National Committee for IHP,
- and the Water Research Commission.

The main objectives of the workshop are:

- to develop strategies for improving women's participation in water management;
- to create conditions and regulations in favour of women empowerment in water resources development programmes;
- to stimulate international and regional co-operation for the exchange of information and experiences.

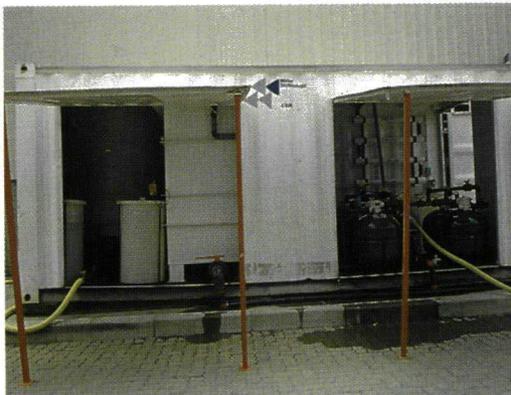
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Cover: Summer floods in the upper reaches of the Moreletta spruit. (Photo: Helene Joubert)

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SASAQS meets at Mtunzini

The Southern African Society of Aquatic Scientists (SASAQS) held their bi-annual symposium in Mtunzini on the north coast of Natal, amidst dune forest and river settings. The symposium, hosted by the Zoology Department and Coastal Research Unit of the University of Zululand, was attended by some 130 delegates.

The scientific programme covered a variety of marine, estuarine and freshwater topics presented under the broad theme of "Aquatic ecosystems: research and industry - working together to maintain biodiversity", and included a number of workshops and visits to places of scientific interest.

Conservationist Dr Ian Garland, in the opening keynote address on Monday, gave an overview of his early recollections of the Mtunzini area and the events that led to the establishment of the SA Association for Marine Biological Research, and the Oceanographic Research Institute in Durban.

Tuesday's proceedings covered biological indicators, indices and aquatic toxicology, as well as fish and aquatic ecology. Keynote speaker, Dr Bruce Richardson from the City University of Hong Kong, outlined a tiered approach to marine contaminant assessment based on studies undertaken in California, Australia and Hong Kong.

Richards Bay Minerals hosted the symposium on Wednesday and talks centred around the impacts of mining on the aquatic system, focussing on industry and the aquatic environment. Delegates were shown around the dune mining operations, including a dredger in operation on one of the mining ponds, the Nhlabane estuary where a dredger crossing had taken place, and rehabilitation of the mined dunes.

Thursday was the last day of the formal programme of papers. Dr Bill Harding presented his keynote address on "The emergence of cyanobacterial toxicosis in the southern and southwestern Cape". His presentation included footage of the decimation of cattle by cyanobacteria. Other papers focussed



Dr Ian Garland (centre front) explaining the Mondi Forest Siyaya River Catchment Conservation project to (left to right) Prof Jay O'Keeffe (SASAQS President), Prof Bruce Richardson (City University of Hong Kong), Dr Victor Wepener (Symposium secretariat) and Prof Digby Cyrus (Symposium chairman).

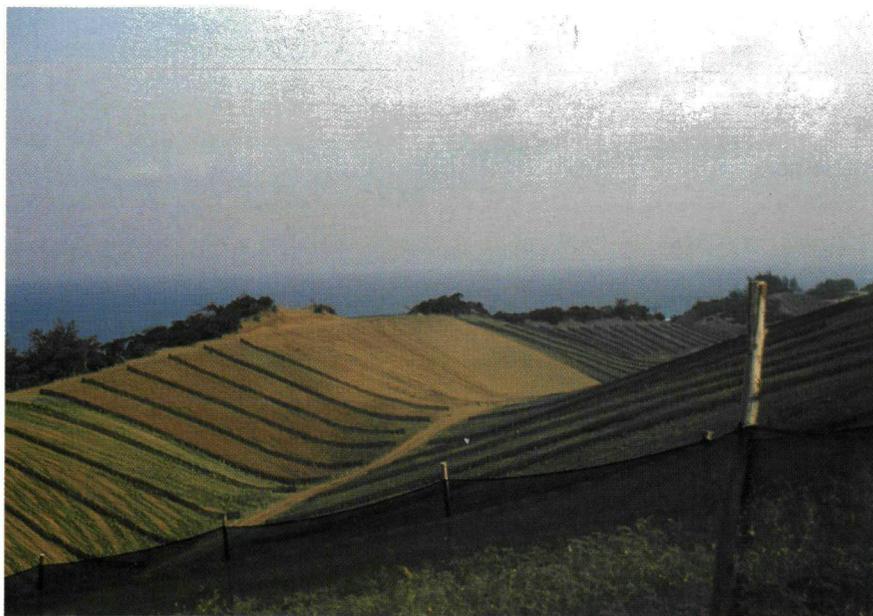


Delegates being shown around at Nhlabane estuary where a RBM mining dredger had crossed the estuary in 1993.

on water resources development, decision support systems, aquatic resources and developing communities, and the Water Act.

Poster session

Posters, specifically the little attention they receive, have always been a point



Dune rehabilitation by RBM after mining of the dunes.

of contention at symposia in the past. The organisers felt that bringing them into the formal proceedings would give the posters more exposure, and so a poster session was held as part of the

oral proceedings. Slides of the posters were shown and the authors were given the opportunity to answer questions arising from their work. Some discussion was generated, however, subse-

quent comment indicated that the more traditional approach of stand-by-your-poster sessions would have been more rewarding.

Awards

At the SASAQS banquet Andrew Gordon and Nicky Motteux, both from Rhodes University, were awarded the student paper prizes, while Peter McMillan and Colleen Todd from the CSIR received the best poster award. In his after dinner speech, Prof Guy Bate entertained the delegates with many amusing anecdotes about peoples (mis-)conceptions regarding water.

St Lucia

On Friday some thirty delegates went on a post-symposium fieldtrip to the estuary mouth at St Lucia. The mouth has been closed for some time and is in the process of being breach. Prof Digby Cyrus gave an overview of the system, its peculiarities, problems and management history.

New Manager for Drinking Water Treatment

The Water Research Commission recently appointed Dr Innocent Msibi as the new Research Manager for the Potable Water Treatment programme. He has taken over the portfolio from Dr Gerhard Offringa who is now Research Manager for Membrane Technology.

Dr Msibi was born (1964) in Northern Zululand and received his schooling in Swaziland. He obtained his BSc degree, majoring in chemistry and mathematics, at the University of Swaziland, along with a Diploma in Education. He worked in the Chemistry Department at the University of Swaziland before going to the University of Essex and the University of Birmingham for post-graduate studies. He holds a PhD (1993) in Chemistry and Environmental Science, and recently added a Diploma in Quality Management to his qualifications.

In his career as an Environmental Chemist he has been involved in several international research programmes,



Dr IM Msibi

such as a study on the long-distance transport of pollutants and their deposition over the North Sea; condensation nuclei and cloud droplet sizes in England and Portugal; management

and assessment of environmental sanitation in Belgium. He has also done research on pesticide residues in soils and water.

In 1995 he attended an intensive training course on Assessment and management of environmental pollution (including monitoring and modelling for water quality management, waste water treatment technologies and biological water quality monitoring), at the University of Ghent, Belgium.

Dr Msibi has been lecturing and supervising projects at the University of the Witwatersrand in Environmental and Analytical Chemistry, as well as General Chemistry, at both undergraduate and post-graduate levels before joining the Water Research Commission.

He is married to Nonhlanhla, and they have two children, Lwazi and Bongeka. As pastimes he enjoys playing and watching soccer, movies, reading and Do-It-Yourself activities.

Graeme Mather - OBITUARY

Graeme Mather, one of the key figures in South Africa's rainfall enhancement research programme, died on 15 August 1997 in Vancouver, Canada, after a relatively short illness.

Graeme Kenneth Mather was born a Canadian on 4 March, 1934 in Calgary, Alberta.

After school Graeme joined the Canadian Air Force where, in October 1954, he received his wings and Commission. The foundation of his life-long flying career was laid in this period, during which he flew Harvards, Mustangs, T-33 Silver Stars, Vampires, F-86 Sabres, Beach-18s and Otters.

Graeme then enrolled at McGill University, from where he graduated with a BSc in Mathematics and Physics in May, 1958.

Graeme's first job was as a pilot with Canadian Pacific Airlines. From May 1958 to December 1963 he flew as a co-pilot on DC-3, DC-4, DC-6 and Bristol Britannia aircraft.

In May 1964 Graeme obtained his MSc in Meteorology from McGill and a month later joined the Flight Research Section of the Canadian National Research Council in Ottawa as an Assistant Research Officer. He instrumented and flew a T-33 single engine jet, doing turbulence research and participated in the Alberta Hail Studies Program "Hail Stop" in the summers of 1970 and 1971.

During 1971 Graeme was contracted by an American firm, Sierra Research Corporation, to manage an operational hail suppression programme at Nelspruit, South Africa. This programme ran from December 1971 through to June 1981. Initially, two Piper Aztecs were used as the seeding aircraft. These aircraft proved to be inadequate for the cloud-top seeding role and were eventually replaced by two Learjets. Graeme became Managing Director of the Nelspruit



Graeme Mather

company, Cansas International Corporation (CIC), which took over the hail suppression contract from the American firm in 1978. The program was terminated in 1981 because of the rising cost of silver and aircraft fuel.

In order to initiate research into the feasibility of augmenting rainfall in the Nelspruit area, the equipment previously used in the hail suppression programme, including aircraft and radar, was purchased by the Company for Research on Atmospheric Water Supply (CRAWS), using funds made available by the Water Research Commission. CIC, contracted by CRAWS to execute the research, in 1986 changed its name to CloudQuest (Pty) Ltd. As Managing Director of CIC, and later of CloudQuest, Graeme effectively directed a major component of South Africa's rainfall enhancement research programme as it unfolded over the next 15 years. During this period, Graeme and his staff also participated successfully in research programmes in Italy, Mexico and France. In addition, they took part in the Southern African

Fire-Atmosphere Research Initiative (SAFARI), an atmospheric ozone measurement experiment, flying the CRAWS instrumented Learjet to make ozone and aerosol measurements over Southern Africa.

Among Graeme's many research accomplishments, the one which gained the widest international recognition, and which has been internationally acclaimed as the most exciting development in the science and practice of weather modification of the past two decades, was the invention of a method of seeding thunderstorms using pyrotechnic flares which release hygroscopic nuclei. Immediately following this invention, in or around 1990, Graeme and his CloudQuest colleagues teamed up with the Weather Bureau's Bethlehem Precipitation Research Group, led by Deon Terblanche, to undertake the National Precipitation Research Programme which, inter alia, proved the efficacy of the new cloud seeding technology.

In September 1992 Graeme was awarded a PhD degree by the University of the Orange Free State for a thesis entitled Randomised Cloud Seeding Experimentation for Assessing Potential for Rainfall Augmentation in Nelspruit District. He has 16 scientific papers in international journals and about an equal number of presentations at international scientific conferences to his credit. His last major contribution was a state-of-the-art review of assessment techniques for experimental and operational cloud seeding programmes, which he presented at the international workshop on Weather and Climate-based Technologies to Benefit Water Resource Management, held in Pretoria in April 1997.

Graeme was an accomplished violinist and once remarked that, should he be forced to retire from cloud physics research, he would seek to join a symphony orchestra.

He is survived by his wife Carlota and children Charles and Tania.

Operating manual published for biological nutrient removal plants

An **Operating Manual for Biological Nutrient Removal Wastewater Treatment Plants** (TT 83/97), compiled on behalf of the Water Research Commission (WRC) by ID Lilley, PJ Pybus and SPB Power of the firm Stewart Scott Inc, is available free of charge from the WRC, PO Box 824, Pretoria 0001. E-mail address for orders: tineke@wrc.ccwr.ac.za. (Overseas price, inclusive of surface mail: US\$ 30.)

The manual is intended for use by managers and owners of biological nutrient removal wastewater treatment works in South Africa and for the staff who operate them.

The objective of the manual is to provide information which will assist trained operators to understand the complexities of biological nutrient removal and to optimise the control of these systems. The presentation assumes that the reader has some experience with activated sludge systems and wastewater treatment works at a level equivalent to a Class IV operator.

The manual does not cover the operation of the inlet works, which comprises screening and degritting, as their operation is common to most wastewater treatment works and has little influence on the performance of the biological nutrient removal processes. It is however important for the protection of mechanical equipment installed in downstream processes.

EUTROPHICATION

The continuous enrichment of waters with nutrients, notably nitrogen and phosphorus in conjunction with carbon dioxide, results in the prolific growth of algae (algal blooms), a process referred to as eutrophication.

The natural eutrophication process is often greatly accelerated by human activities in the catchment areas of lakes and impoundments, through the increased input of nutrients from both

diffuse and point sources. Nutrients introduced from diffuse sources are difficult to control because as the name suggests they are introduced in relatively small concentrations over large areas from sources such as fertilisers, livestock, informal settlements, etc. Nutrients introduced from point sources are easier to control as the nutrients that originate from residential and industrial areas are concentrated at a point by means of sewers. The focus of this manual is on the effective operation of various biological works to remove the nutrients responsible for eutrophication from these point sources.

SYSTEMS

The manual says the limitation of nutrient discharges into waters from point sources is usually achieved by biological means, either by way of biological trickling filters or activated sludge systems. Both these systems utilise naturally occurring bacteria to reduce the nutrient concentrations entering waters. Artificial conditions favourable for the controlled growth of these bacteria are created within these systems and results in concentrations of at least a million times that found in the natural environment. The bacteria in these systems utilise the nutrients for growth and in this way the nutrients pass from the liquid phase into the solid phase and are concentrated in the biological culture.

Although the biological trickling filters and activated sludge works are effective in removing carbon, it is only the activated sludge works that can be designed to remove nitrogen and phosphorus from wastewater streams effectively. This is achieved biologically by the incorporation of aerobic (oxygen and nitrate present), anoxic (nitrate present but deficient in oxygen) and anaerobic (deficient in nitrate and oxygen) zones. In the aerobic zone, carbon is removed and ammonias are oxidised to nitrate, in a process called nitrification. In the anoxic zone, the nitrates are reduced to nitrogen gas via the denitri-

fication process. The aerobic zone is essential for inducing biological phosphorus removal. Systems which do not incorporate these features generally rely on iron salts such as ferric chloride and aluminium such as aluminium sulphate or lime to precipitate phosphorus and so to limit eutrophication.

BIOLOGICAL NUTRIENT REMOVAL

The advantages and disadvantages of biological nutrient removal, as listed in the manual, are as follows:

Advantages:

- Savings in chemical costs.
- It does not add significantly to the salinity of receiving waters
- The long sludge ages required by the process produce sludges which are not odorous and which remove nitrogen reliably.
- It produces sludges suitable for use as soil conditioners if the wastewater does not contain excessive heavy metals from industrial wastes.
- Some of the alkalinity and oxygen used during nitrification is recovered in

Disadvantages:

- The efficiency of removal is influenced by the wastewater characteristics.
- The phosphorus-rich biological sludge wasted from the system will release phosphorus back into the liquid stream if it is not treated correctly.
- Because unaerated zones are introduced, relatively long solids retention times (sludge ages) are required in the biological reactors to ensure nitrification in winter, resulting in large biological reactors.
- Anaerobic digestion of phosphorus-rich biological sludges in the presence of magnesium can result in struvite precipitation causing blockages in digester pipework. Unfortunately, the maximum concentration of magnesium to avoid precipitation is not known.
- It requires greater skills from the operating staff.

Salt balance of the Vaalharts irrigation scheme studied

An earlier report based on a preliminary "salt balance" for Vaalharts, the largest irrigation scheme in South Africa, indicated that only about twenty per cent of the salts in the irrigation water made available to irrigators are retained in the return flow which drains from the area via the Harts River. Since this "imbalance" cannot be sustained indefinitely a study of the overall water and salt balance of the scheme was undertaken to re-evaluate the earlier findings.

In the study, funded by the Water Research Commission (WRC), two researchers from Stewart Scott, CE Herold and AK Bailey, used and calibrated a hydro-salinity simulation model to patch gaps in the historical flow and water quality record and to simulate the long term behaviour of the system.

According to a report released by the WRC, the final results confirmed that "Vaalharts is operating as a salt sink that has accumulated two-thirds of the total dissolved salts (TDS) load contained in the irrigation water since the scheme was commissioned in the late 1930s".



Drainage canal in the Taung area (Note seepage from bottom line of holes whereas no seepage from upper line of holes).

The report says the aims of the study were as follows:

□ Quantify the long term historical macro-scale water and salt balance (in terms of both total dissolved salts (TDS) and its main ionic constituents) of the Vaalharts irrigation scheme to determine the extent of salt loss or accumulation.

□ Analyse available flow and water quality records to quantify the effect of the sub-surface drains (the installation of which commenced in the mid-seventies) on irrigation return flow volumes, TDS loads and TDS composition.

□ Study available agricultural, meteorological, hydrological, water quality, soils and geohydrological data to gain an understanding of the underlying hydro-salinity processes.

□ Where necessary propose and initiate additional monitoring and field investigations to supplement the available data.

TASKS

The main tasks undertaken were the following:

□ Literature survey

A literature survey has been done to identify studies of a similar nature that have been carried out elsewhere. In particular, relevant reports on the Vaalharts irrigation scheme itself have been examined.

□ Macro-scale water and salt balance

The macro-scale water and salt balance was based on river monitoring in the Vaal and Harts Rivers and did not involve detailed studies of individual plots or irrigation blocks.

Available hydrological, water quality, meteorological, water use and other relevant data were collected and entered into a project data base. Early flow and water quality records have been examined and patched using hydro-salinity models to estimate the water and salt loads supplied to and returned by the Vaalharts irrigation scheme. Computer software already developed in-house by the researchers was used to check and patch deficient flow and water quality records. Existing hydro-salinity models were used to simulate the long term salt balance of the Vaalharts irrigation scheme.

□ Effect of sub-surface drains

Available data were analysed in an attempt to detect the effect of the recent installation of extensive sub-surface drains on the global percentage return flow and salt export. Hydro-salinity modelling was used to eliminate the effect of long term hydrological fluctuations that tend to mask water quality trends.

□ Hypothesise processes

The results of the salt balance analyses were examined, together with relevant papers and reports and available agricultural, meteorological, water quality, soils and geohydrological data to gain an insight into the dominant processes controlling the storage and release of salt at Vaalharts. The most likely explanations for the apparent retention of salt at Vaalharts have been hypothesised. Cost-effective means of testing these hypotheses have been sought.

CONCLUSIONS

The researchers say in their report that the following conclusions can be drawn from the results of the study:

□ Data deficiencies

A large amount of basic information regarding the historical development of the Vaalharts irrigation scheme (such as irrigated areas, volumes of water supplied, cropping patterns, etc.) appears to be unobtainable. This necessitated patching by means of interpolation and extrapolation. The flow records for Spitskop Dam, Espagsdrift weir and Mt Rupert weir were found to be inaccurate.

□ Hydro-salinity modelling

The hydro-salinity water quality model WQT has been calibrated successfully for both the Upper Harts (i.e. the catchment upstream of Taung weir) and Middle Harts catchments (i.e. the catchment downstream of Taung weir). The calibrated model was then used to simulate conditions up to the year 2030.

Owing to the inaccuracies in the flow gauging at key hydrological stations as well as other data deficiencies, it was to be expected that the modelled values would not fit the observed values that well. The modelled values do, however, provide a reasonable first order approximation to the observed values.

□ Estimation of irrigation losses

The annual return flow from the North Canal area to the Harts River for the period October 1976 to September 1991 were calculated from upstream and downstream river flow records and simulated monthly runoffs from the incremental catchment. The mean for this period came to 25 million m³ per annum which is about 11 per cent of the annual supply to the North Canal area.

A simple crop water balance was carried out to calculate the annual total irrigation losses (i.e. the return flow to the river plus deep percolation to groundwater storage). These were compared with similar estimates in earlier studies. In some instances, this exercise revealed wide discrepancies between the irrigation loss estimates arrived at using the different methods. All three methods appear to share the common weakness that none of them adequately account for the inter-relationship between the processes governing infiltration, surface runoff and soil moisture storage. The accuracy of all the methods was also adversely affected by the coarse monthly computational time step.

Estimates of the annual amounts of water percolating to deep groundwater storage were made by subtracting the calculated annual return flows to the Harts River from the estimated total irrigation losses. These estimates were compared with those made by other researchers using four alternative methods of calculation. These alternative estimates of the mean annual deep percolation ranged between 33 million m³ and 63 million m³. This wide band of estimates is indicative of the inherent inaccuracy resulting from the uncertainties associated with this type of calculation. The alternative methods were employed to provide high and low estimates of possible deep percolation rates.

□ Change in groundwater storage in North Canal area

Two alternative hypotheses of the historical change in groundwater storage in the North Canal area were examined. The first was based on the assumption that the calcrete layer is sufficiently porous to permit percolation to the deeper groundwater table, which has been gradually filling over the years. The second supposed that there is no effective link between the perched



Outlet pipe from the experimental farm into drainage canal in the Taung area 5/10/92.

water table above the calcrete layer and the underlying deep groundwater table.

Since the perched water table is relatively shallow, the second hypothesis appears to be incapable of explaining the long term retention of total dissolved solids (TDS) in the North Canal area. Nor can it account for the difference between the calculated total irrigation loss and the return flow to the Harts River, even if the lowest estimate of the total irrigation loss is used.

The first hypothesis appears to be capable of explaining all of the main historical trends, provided the lower end of the range of estimated mean annual deep percolation estimates holds true (or the deep groundwater storage capacity is larger than that assumed). The implication of this set of assumptions is that the deep groundwater table has not yet completely filled. This hypothesis warrants further investigation to verify its validity.

□ Historical salt balance

Model calibration results indicated that most of the TDS load returned to the Harts River comes from the North

Canal area with much smaller contributions from the Taung area and the West Canal area. Some 65 per cent of the TDS load contained in the irrigation water supplied to the Vaalharts irrigation scheme appears to have been retained. This compares with the first order estimate of 80 per cent retention (based on data available up to the end of September 1984). The difference between the two estimates can be explained partially by the additional data that have since become available, including the extremely wet 1987 hydrological year, and improved estimates of historical water supply prior to 1954. The errors in streamflow gauging which have been discovered during this study also contribute towards this 15 per cent discrepancy.

The new estimate verifies the main finding of an earlier report, namely, that most of the TDS load in the irrigation water has been retained, holding the potential for future salinity problems. Such problems could arise when a balance is eventually attained between the incoming and outgoing TDS loads, resulting in increased export of TDS to the downstream river system.

□ Long term future salt balance

Projections of the future TDS balance at Vaalharts were carried out using model simulations assuming continued loss of salts to the deep groundwater storage. Based on these assumptions Option 1 (the 1990 *status quo* option, which assumes no further irrigation development or change in water allocation), results in little change in the mean annual TDS load returned to the Harts River. For this option the deep groundwater is expected to have accumulated 60 per cent of the applied TDS load by 2030, provided there are no water restrictions during this period (since the model projections assumed that the full irrigation demand is met). If the frequency and intensity of water restrictions during the next 40 years approximates that for the historical period, then a 65 per cent TDS accumulation can be expected.

Option 2 (which takes account of new irrigation developments and increased water allocations that are already in the process of being implemented), is expected to increase the mean annual TDS load returned to the Harts River by about 10 per cent. The increased water allocations have the effect of reducing

the accumulated TDS load by the end of 2030 to 59 per cent (since a larger proportion of the applied TDS load will have reached the Harts River).

Both of the above projections are based on the assumption that the deep groundwater has sufficient available storage capacity to continue to accumulate deep percolation. However, if at some point in time the available storage is exhausted, then a balance between the TDS load entering the irrigated lands and that leaving via return flow to the Harts River will begin to emerge. Although the TDS load already accumulated in the deep groundwater is not likely to return to the Harts River (or if it does return, the discharge rate will be too small to make a substantial impact on the TDS balance of the Harts River), a balance between supply and return flow TDS loads will result in a two- to three-fold increase in the mean annual TDS load returned to the Harts River. It is therefore important to establish when this very substantial increase in TDS export can be expected to occur and to evaluate the impact on the salinity regime of the downstream river system.

□ Comparison of TDS and chloride retention

For the period October 1975 to September 1991 the TDS retention was estimated at 57 per cent of the applied irrigation load, while that for chloride was estimated at only 40 per cent. The extended long term TDS retention of 65 per cent is somewhat higher than that for the 16 year period for which TDS and chloride could be compared. Hence in the long term the chloride retention can be expected to be about 46 per cent. This implies that chemical transformations and adsorption processes could be removing a significant portion of the TDS load that has apparently been retained in the groundwater. Since chloride is a highly mobile ion that is unlikely to be removed by these processes, the results indicate that at least 70 per cent of the observed net loss of TDS (i.e. 46 per cent of the TDS load in the supply water) is likely to have been to deep groundwater. This implies that up to 30 per cent of the salt loss could be attributable to chemical transformations and adsorption processes, part of which may be a permanent loss from the water phase. However, this figure could well be less than 30 per cent since the presence of the chloride ion in rainfall, or even the displacement

of chloride from the original groundwater, may have altered the balance between TDS and chloride without actually removing other ions from the water. It is also unlikely that the irrigated soils can continue to remove salts indefinitely.

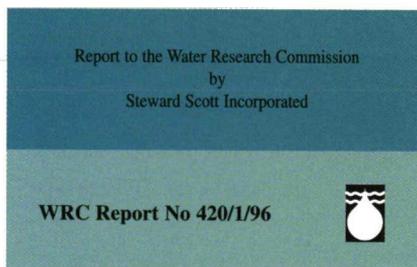
□ Effect of sub-surface drains

The effect of the sub-surface drains on irrigation return flows (in terms of both water and TDS load) has been totally obscured by wet and dry hydrological cycles and extraneous factors such as over irrigation during some periods, water restrictions and the plugging of drains during drought conditions. The drains appear to have had much less effect on return flows than have climatic fluctuations.



Long Term Salt Balance of
the Vaalharts Irrigation Scheme

CE Herold ● AK Bailey



□ Hypothesis of processes

The main hypotheses are as follows:

(i) The calcrete layer is sufficiently permeable in enough places to permit the percolation of water and salts to a deeper groundwater table. This is where most of the "lost" TDS load appears to have accumulated.

(ii) This deep groundwater table may not yet have filled, but may do so at any time in the future. (Little information is available regarding the remaining storage capacity and the rate of filling.)

(iii) The deep groundwater table's groundwater flow contribution to the Harts River is (at present) assumed to be small relative to that from the sub-surface drains and the perched water table above the calcrete layer.

(iv) When the deep groundwater table fills, a rough balance between the TDS load contained in the irrigation water supply and that in the return flow to the Harts River is expected to occur. The return flow will then increase substantially and the TDS load returned to the Harts River is likely to increase by a factor of two to three.

(v) Fallow lands, the unirrigated lands separating the irrigated areas from the Harts River and a transition area along the eastern, southern and to a lesser extent, the northern boundary of the irrigation area are all likely to exhibit elevated groundwater tables and contribute to the evapotranspiration loss from the irrigated areas.

□ Future implications

The accumulation of about two-thirds of the applied TDS load at Vaalharts implies that the salinity of the groundwater and that of the irrigation return flows is still a long way from reaching a state of dynamic equilibrium with the supply water salinity. Eventual filling of the available groundwater storage is expected to result in a state of equilibrium with the mean annual TDS load returned to the Harts River matching that contained in the irrigation water. The system response to these changes will be complicated by the effect of the installation during the 1970s of irrigation sub-surface drains, which can be expected to intercept part of the water and salt load draining past the bottom of the crop root zone. This should serve to slow the rate at which salinity levels build up in the groundwater. However, it will also ensure that a larger proportion of the salt associated with the applied irrigation water will be returned directly to the Harts River. This implies a more rapid rise in return flow salt loads after the groundwater table fills, resulting in the new state of equilibrium being reached more quickly than would otherwise have been the case. The net result of the eventual increased TDS export on the downstream river system could be very serious indeed.

Copies of the report entitled **Long term salt balance of the Vaalharts irrigation scheme** (WRC Report 420/1/96) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail address: Tineke@wrc.ccwr.ac.za (Overseas price: US\$ 25 - via surface mail.)

Methodology developed for assessing climate change scenarios

Results from a research project funded by the Water Research Commission (WRC) have demonstrated that an "empirical down-scaling technique" based on the use of neural nets is a valuable approach toward creating more robust climate change scenarios at suitable spatial and temporal scales, for use by South African climate change impacts researchers.

According to the researcher, BC Hewitson, of the Department of Environmental and Geographical Science at the University of Cape Town, the methodology offers a technique by which researchers may derive local climate scenarios from global-scale scenarios generated using general circulation models. It represents a significant advance over the climate change data currently available from other sources.

Further results based on the methodology should in the future be of direct interest to South African researchers in a wide spectrum of disciplines. However, "while the initial scenarios developed here are consistent with broad expectations of climate change impacts, they should not be considered too definitive as further work is needed to develop confidence levels for the scenarios."

The results are summarised in a final report entitled **A methodology for developing regional climate change scenarios from general circulation models** (WRC Report 594/1/97). Copies of the report are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order address: tineke@wrc.ccr.ac.za. (Overseas price: US\$ 15, via surface mail.)

South Africa's climate is subject to high inter-annual variability and presents significant vulnerabilities in the face of probable global climate change. Regional impacts from global changes are most likely to be manifest in the hydrological aspects which will impact water resources and water dependent infrastructures most strongly. In the face of the long lead times required for planning and policy development it is vital that an accurate understanding be developed of the probable regional consequences of global environmental change for the next five to ten decades.

The most viable tools for such investigations are general circulation models which attempt to simulate the global geophysical system encompassing the land, ocean and atmosphere. However, while general circulation models manage to simulate global-scale processes with considerable success, the models are also relatively coarse resolution tools and fail to resolve the detail of regional climate variability, especially with regard to hydrological variables. It is particularly at these higher resolution scales, which the general circulation model fails to capture adequately, that climate change information is most needed.

This shortcoming may be addressed through the use of "downscaling" which utilises the dependence of local-scale climates on the large scale circulation to derive regional information. In essence, downscaling uses observed data to derive relationships between the larger scale atmospheric circulation and local climate parameters. These relationships may then be used in conjunction with the more viable large scale circulation from general circulation models to derive local climate information based on the general circulation model simulation of atmospheric circulation.

OBJECTIVES

The primary aim of the project was to derive regional scenarios for global climate change impacts on regional pre-

cipitation and temperature over South Africa as a consequence of anthropogenic increases of atmospheric carbon dioxide. In doing so, three objectives were targeted:

- To validate general circulation model simulations of atmospheric controls on regional precipitation and temperature over South Africa;
- To develop a new non-linear methodology for cross-scale climate relationships;
- To develop quantified estimates of the regional changes for use as input to hydrological and agricultural models.

the regional climates as a function of the larger scale circulation. For both the downscaled precipitation and downscaled temperatures, the nature of the near-daily event is well captured, as well as the seasonal timing and amplitude for both variables.

General circulation models' circulation data were then evaluated for validity over South Africa using a principal components analysis technique. The circulation in terms of the spatial distribution of variance was shown to be a reasonable reflection of present day circulation. The artificial neural nets relationships between circulation and local climate were subsequently applied to the general circulation models' daily circulation data from a simulation of present day conditions and the regional climates derived.

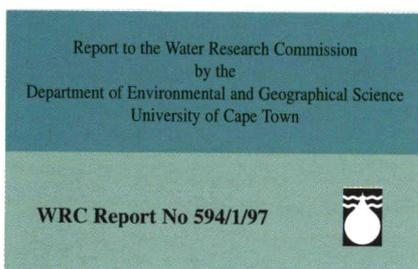
The regional climates generated by the general circulation model's circulation were shown to demonstrate a high degree of similarity to the observed regional climates and further indicates that the general circulation model reasonably simulates the large scale circulation forcing over South Africa. The relationships were then applied to data from a general circulation model simulation of future conditions under doubled atmospheric carbon dioxide, and the results differenced from the present day simulation to generate the carbon dioxide induced changes in regional climates.

The primary results of consequence for climate change impacts indicate that, as a function of changes in the general circulation models' circulation forcing, there are reductions in the regional summer precipitation over the summer rainfall region extending from the east coast through to the central and northern regions of the country. These reductions are of the order of a ten to fifteen per cent decrease in mean monthly precipitation. However, the results are preliminary, based on only one model, and should be used only as an initial possible indication of change.



A Methodology for Developing Regional Climate Change Scenarios from General Circulation Models

BC Hewitson



RESULTS

The investigation has led to the development of a new downscaling procedure for South Africa based on artificial neural nets to derive relationships between circulation and local precipitation and temperature on a one degree (1°) latitude-longitude grid. These derived relationships were evaluated for accuracy, and demonstrated that the relationships do successfully capture both short and long term variability in

Using SEDIDAF to remove suspended solids from paper mill effluents

In the pulp and paper industry significant concentrations of suspended solids, comprising both less dense particles (mainly fibres) as well as denser particles such as clay, are present in the effluents generated by the manufacturing mills. Very often large volumes of these effluents are disposed of into the environment where they could cause widespread environmental damage.

A common practice for paper mills in South Africa is to try and recover the suspended solids in the effluent streams and re-use the fibres together with raw materials. To this end treatment processes such as clarification, centrifugation and filtration are used.

These conventional treatment processes are not always effective at removing certain suspended solids and therefore modern dissolved air flotation (DAF) units have been installed at a number of local mills. These units achieve improved suspended solids removal, especially of the lighter organic fraction that do not easily settle. They are, however, not effective at removing the denser inorganic solids. These solids tend to settle out in the flotation units and this leads to operational and maintenance problems.

The full-scale application of conventional settling or clarification as a treatment process ahead of flotation is not economical. In addition, the sedimentation ahead of flotation can lead to anaerobic conditions in the settling tank.

To address these concerns, the Water Research Commission (WRC) funded a project at the CSIR's Division of Water, Environment and Forestry Technology to investigate, at pilot-scale, the use of a compact inclined plate settler integrated ahead of a flotation cell. The



The SEDIDAF experimental unit

advantage of this configuration is the high rate of sedimentation coupled to the shorter solids retention time within the unit and the capability to remove the lighter suspended solids fraction.

According to the final report compiled by the researchers, DC Whyte and CD Swartz, the most significant conclusions of this study are:

- High percentages of removal for suspended solids can be obtained with the combined SEDIDAF process;
- The settling stage of the process contributes most to the overall removal of solids from the effluent;
- Effective suspended solids removal can be obtained with settling in an inclined plate settler at surface loading rates as high as 10.9 m/h;
- Improved suspended solids removal

is obtained at lower flotation zone velocities in the DAF stage;

- The DAF stage does not only remove the organic fraction of the suspended solids but also inorganic particles; and
- The settling stage does not only remove the inorganic fraction of the suspended solids, but also organic particles.

Copies of the report entitled **The removal of suspended solids from pulp and paper effluents by employing the combined sedimentation flotation process** (WRC Report 333/1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail address: tineke@wrc.cw.ac.za. (Overseas price, via surface mail: US\$ 10.)

Solid waste practice in SA's developing urban areas evaluated

The Water Research Commission appointed the Palmer Development Group in January 1994 to carry out an evaluation of solid waste practice in South Africa's developing urban areas.

The objective of the project was to provide relevant and up to date information and analysis upon which to base rational policy and practice so that the large and increasing demand for solid waste services in developing urban communities may be met in an economically efficient and equitable manner.

The project was conceptually divided into three phases, namely:

Phase 1: Overview

□ A review of the current status with domestic solid waste management internationally.

□ Execution of a survey of solid waste practice in the urban areas of South Africa, based on questionnaires and interviews, to determine who has access to adequate services, what type of systems are being used and to obtain as much operating and cost information as possible.

Phase 2: Evaluation using case studies

□ Evaluation of solid waste practice to determine the following: level of access and acceptance by communities; technical options; cost; financial viability; management efficiency and environmental impact. The method of evaluation is based largely on case studies where the situation in specific areas has been investigated.

Phase 3: Key issues and guidelines

□ Holding of workshops in different



Solid waste - a serious problem in South Africa.

centres around the country to get input from people active in the field, using the findings of the first two phases as a basis.

□ Preparation of a summary of the situation with solid waste practice, identifying key areas for action and preparation of draft guidelines for the planning and management of solid waste management systems.

As part of these three phases the following series of documents have been prepared:

□ A main report titled **Evaluation of solid waste practice in developing urban areas in South Africa.**

□ **Provincial profiles: status of solid waste practice in each province:** Western Cape, Northern Cape, Free State, Eastern Cape, Natal/Kwazulu, Mpumalanga, Northern province and North-West.

□ **Metropolitan profiles: status of solid waste practice in the three major metropolises:** Gauteng, Cape Town metropolitan area and Durban functional region.

□ **Case studies of six urban areas in South Africa:** Khayelitsha (Cape Town), Umlazi (Durban), Soweto and Alexandra (Gauteng), Rini (Grahamstown) and Winterveld (North-West).

□ **General publications:** Costing of domestic solid waste management systems and Draft guidelines for domestic solid waste collection.

The documents are compiled in two reports - WRC Report 629/1/96 and WRC Report 629/2/96. To order a copy free of charge, please write to the Executive Director, Water Research Commission, PO Box 824, Pretoria 0001. E-mail address: tineke@wrc.ccwr.ac.za. (Overseas price, inclusive of surface mail: US\$ 25.)

Evaluation of Solid Waste Practice in Developing Urban Areas of South Africa

Report to the Water Research Commission by the Palmer Development Group

WRC Report No 629/1/96



Guidelines for selection of treatment plants for rural areas

Ten water treatment plant packages have been evaluated by researchers of Umgeni Water in collaboration with the Pollution Research Group of the Department of Chemical Engineering at the University of Natal.

In their report to the Water Research Commission the researchers, WJ Voortman and CD Reddy, say that prefabricated package water treatment plants have considerable potential for addressing the need of potable water supply to rural and peri-urban areas in South Africa.

According to the report, **Package Water Treatment Plant Selection**, the advantages of prefabricated package water treatment plants include:

- suitable capacity for small and isolated settlements in rural areas;
- rapid deployment, as most package plants are compact and can be transported by road and operating at full capacity within a few days of delivery;
- mobility: many package plant systems are suitable for dismantling, relocation and installation within a short time period;
- lower capital costs than fixed structures or processes of similar capacity;

simplified operation and maintenance procedures compared to conventional water treatment processes.

However, there has been a reluctance by consultants, development agencies and smaller local authorities to specify package plants for use in their water supply schemes, because of lack of a formal evaluation methodology by which comparisons of plant performance could be made, as well as uncertainties about the long term operating costs and performance of package water treatment plants.

The Water Research Commission funded a joint project by Umgeni Water and the Pollution Research Group (University of Natal) to formulate criteria and investigate the performance of package plants.

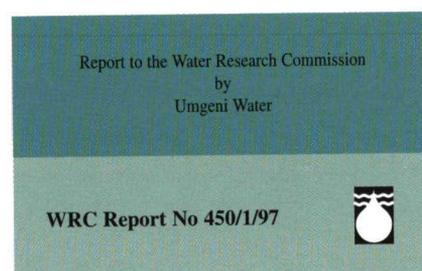
Copies of the project report, comprising guidelines and a limited comparative performance study, entitled **Package Water Treatment Plant Selection** (WRC Report 450/1/79) is now available from the Water Research Commission, PO Box 824, Pretoria 0001 or E-mail: tineke@wrc.ccwr.ac.za
Foreign orders please note: US \$30 per copy, via surface mail.



Package Water Treatment Plant Selection

- 1 Guidelines
- 2 Limited Comparative Performance Study

WJ Voortman • CD Reddy



Report to the Water Research Commission
by
Umgeni Water

WRC Report No 450/1/97



The supply of potable water to rural and peri-urban areas is considered to be a national development priority, as reflected in the recent white paper on water and sanitation compiled by the Department of Water Affairs and Forestry. Furthermore the Water Research Commission (WRC) has also acknowledged the need for research into appropriate technology for rural and peri-urban areas as highlighted in the 1992 WRC master plan on research of potable water.

According to the researchers, package and pre-constructed plants have a major role to play in the provision of water to remote rural areas. Package water treatment plants also form part of Umgeni Water's strategy in providing a cost-effective supply of purified water to areas where the population does not have a reliable supply. However, there has been a dearth of information in South Africa on package plants for

of package water al areas

water treatment under local conditions, and no formal testing programme or evaluation criteria were available.

OBJECTIVES

The objectives of the joint project were:

- to establish a set of performance criteria for package water treatment plants.
- to develop a testing methodology for evaluating package plants from these criteria.
- to evaluate a number of package plants against the performance criteria using the methodology.

(Since there are a variety of performance objectives for package water treatment plants these had to be codified and ordered. Examples of the performance objectives are:

- Raw water characteristics and availability
- Volume of water required and demand elasticity

- Sophistication of operating staff
- Source of power
- Required plant life, and
- Service frequency.)

- to disseminate information in the form of Guidelines on the performance of package water treatment plants.
- to provide feedback on plant performances to the manufacturers, allowing them to improve their products.

Evaluation Criteria

A list of evaluation criteria based on the engineering experiences of members of Umgeni Water and the Pollution Research Group was prepared by the project researchers. A postal survey was conducted in which various consultants, research institutions and Southern African government institutions were requested to comment on the proposed list of evaluation criteria.

A number of useful comments were received and incorporated into the eval-

uation criteria. The criteria were then used to establish an evaluation methodology for package water treatment plants. The importance of having operating manuals written in the operator's home language was stressed by several respondents to the postal survey.

Package Plants Evaluated

The ten package water treatment plants (see table below), comprising a range of different turbidity removal and disinfection technologies, were evaluated during the experimental phase of the project. The evaluations were carried out from October 1992 to July 1994 and the plants were evaluated as supplied. Minor modifications were carried out on some of the systems to improve performance and these modifications are documented in the reports on the individual plants.

Water Quality Guidelines

The quality of treated water produced

The Ten Package Water Treatment Plants evaluated were:

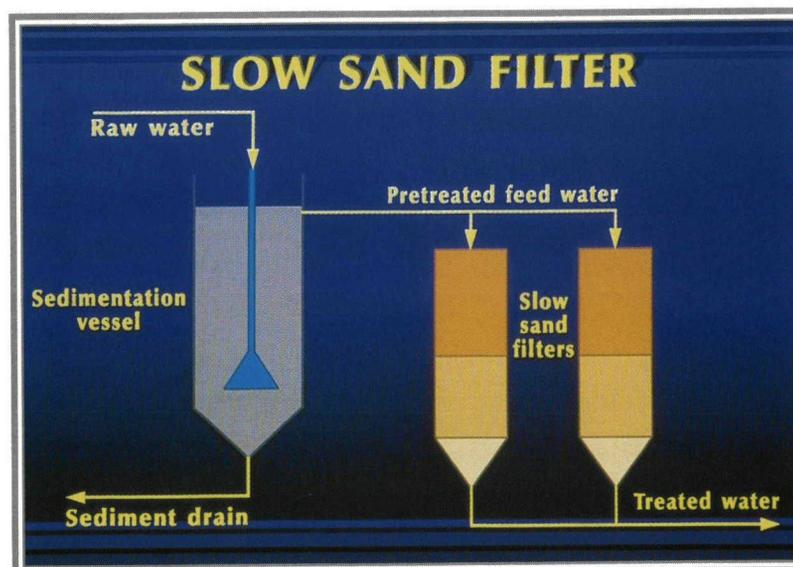
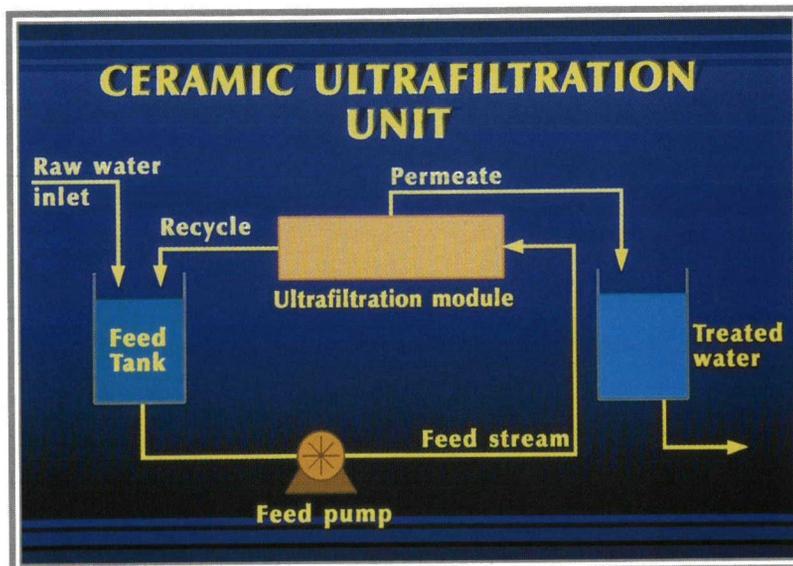
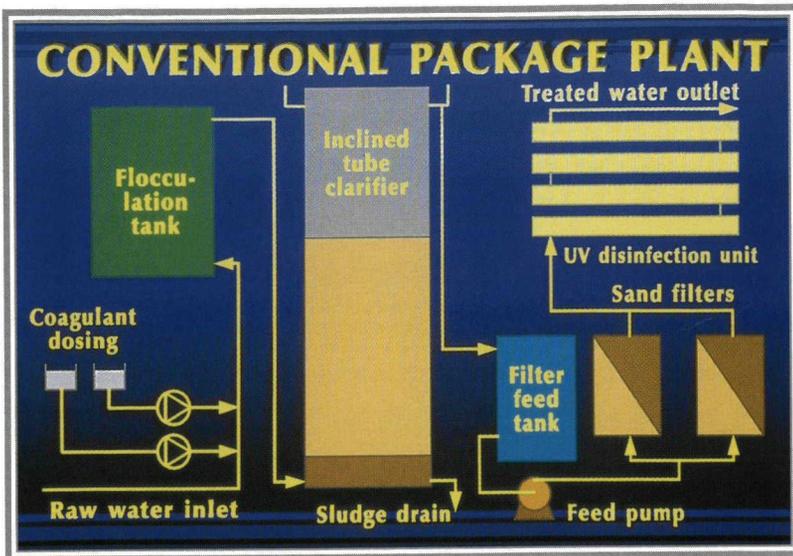
SUPPLIER

- 1) Atomic Energy Corporation (AEC)
- 2) Aquatek (Pty) Ltd
- 3) In-house design
- 4) Explochem Water Treatment (Pty) Ltd
- 5) Division of Water Technology, CSIR
- 6) Explochem Water Treatment Pty (Ltd)
- 7) Johnson's cc.
- 8) Select Water & Engineering Services
- 9) Vector Environmental Technologies Inc.
- 10) In-house design

PROCESS TECHNOLOGY

- Ceramic microfiltration
- Dual media direct pressure filtration with chlorination
- Diatomaceous earth filtration
- Crossflow microfiltration
- Conventional* with optional UV disinfection
- Direct upflow filtration
- Solar powered UV disinfection with cartridge filtration
- Batch settling and filtration with chlorination
- GAC series filtration with iodine disinfection
- Slow sand filtration

* The package plant consisted of sequential coagulation/flocculation, sedimentation, filtration and disinfection.



by the plants was assessed in terms of the 1994 draft guidelines for potable water quality produced by the Department of National Health and Population Development.

Package Plant Evaluation Results

The package plants were all evaluated according to the evaluation methodology and detailed reports on their design and performance are provided in the WRC report.

The range of technologies varied from simple (e.g. slow sand filtration) to sophisticated (e.g. GAC series filtration with iodine disinfection)

Water Treatment Performance

The performance of each package plant was evaluated with regard to the following aspects:

- Disinfection
 - Turbidity and aesthetics
 - Micro-pollutant removal
 - Sludges and effluents
 - Plant life, robustness and reliability
 - Potential for upgrading capacity
 - Control systems
- (Six of the systems were manually controlled, two were partially automated and two were fully automated) and,
- Maintenance requirements.

The performance results for each of the plants with regard to these aspects are given in detail in the WRC report.

Operation and operators

Proper operation of package water treatment plants is essential if a reliable supply of potable quality water is required. The ten systems under investigation were rated in terms of complexity of operation on a scale which varied from simple to expert. Recommendations are given in the report with regard to the skills and training that an operator would require to operate a systems.

None of the operating manuals for the systems under investigation were available in any of the indigenous African languages. Since these systems are likely to be used in rural areas, it is essential that operating manuals are

made available in languages that are familiar to the community being served.

Capital and Operating Costs

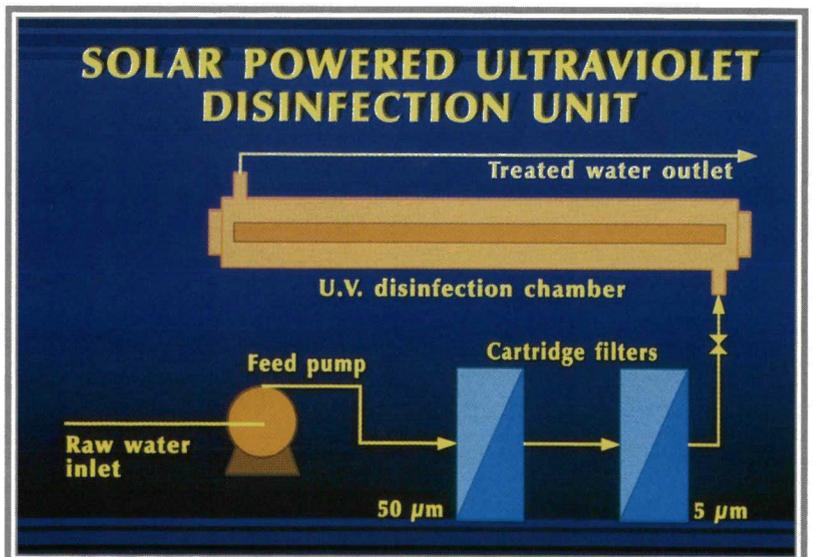
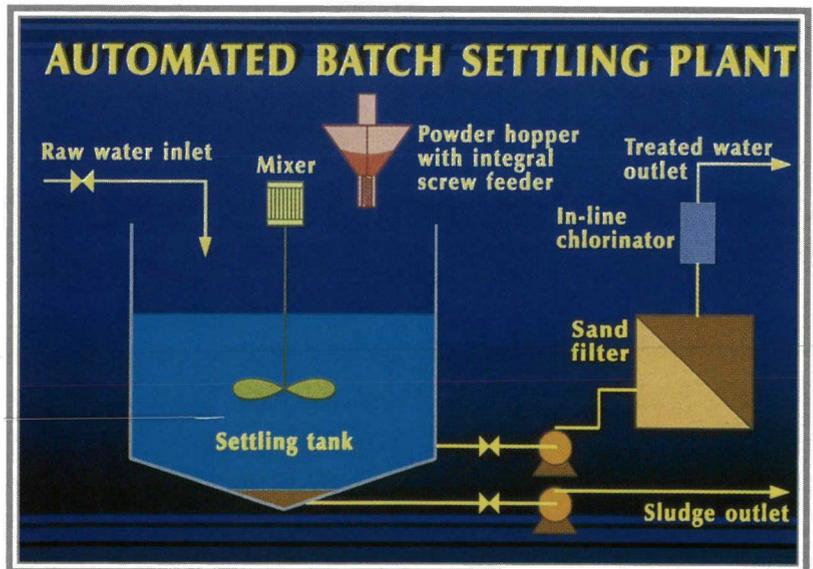
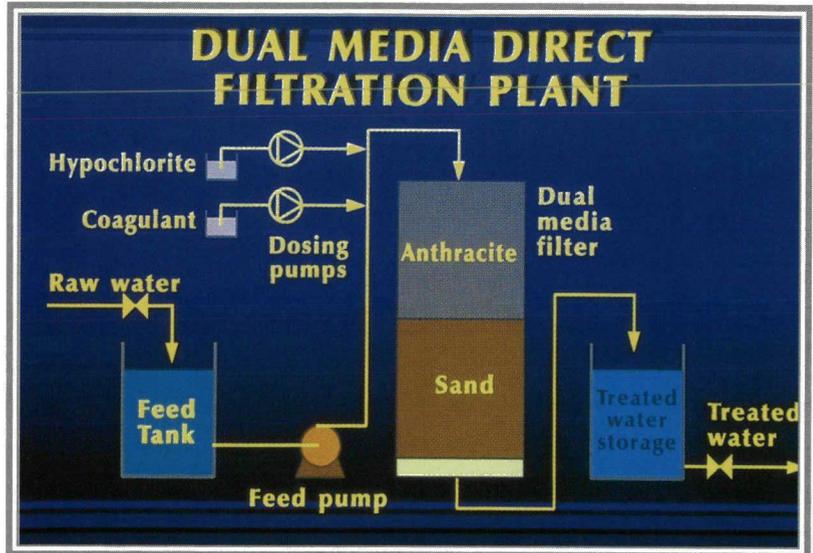
The capital costs quoted in this study are based on the manufacturer's 1994 ex-factory price, excluding VAT. The cost of delivery, raw water provision, electricity supply and civil work at the treatment plant site is not included. The considerable variations in the capital costs of the package plants are mainly due to variations in capacity, from 11 m³/d to 240 m³/d, and variations in the water treatment technology. When the capital costs are normalised for plant capacity, they range from R 6000/m³/d for the smaller capacity, high technology units to approximately R 200/m³/d for the larger capacity, lower technology processes. The additional cost of delivery, establishment of site infrastructure and engineering fees can effectively double these ex-factory costs. By comparison, the normalised capital cost of Umgeni Water's new 250 Ml/d Midmar plant will be approximately R 460/m³/d (including entire water treatment plant, sludge treatment plant and engineering fees but excluding the raw water pump-station and the treated water storage).

Operating costs for the plants were estimated from the sum of the energy, labour, chemical and maintenance costs. Capital redemption costs and depreciation are not included. Labour costs were estimated at a R 7,00/h rate, while actual costs were used wherever possible to estimate the energy, chemical and maintenance costs.

All of the systems were evaluated as they were supplied and it was expected that there would be a wide range of operating costs. However, it must be stressed that each system has its niche in the market and will have an application depending on a variety of factors that have been detailed in the report.

Guidelines

A set of guidelines for the selection and specification of package plants has been produced. This report is intended as a basis for a guide that will allow consultants and water authorities to make an informed choice when selecting package water treatment plants.



Treating eutrophic and coloured waters with Peroxone and other oxidants

“The use of Peroxone in potable water treatment has a niche position and should be used for the removal of specific micropollutants or pesticides.” This is said in a report published by the Water Research Commission on the effectiveness of Peroxone as a chemical oxidant on eutrophic and coloured waters. Results of comparative studies performed with ozone, hydrogen peroxide, chlorine, chlorine dioxide and ultra violet irradiation are also included in the report.

According to the researcher, CJ van der Walt, previously from the Division of Water, Environment and Forestry Technology at the CSIR, and now at GFJ Inc, the specific objectives of this research project were to investigate the oxidation efficiencies of the above oxidants on colour removal, taste and odour removal and the effect of ozonation on flocculation and coagulation processes. He says a number of bench-scale, pilot-plant and full-scale plant studies were undertaken to quantify the use of these oxidants for the removal of specific pollutants.

Copies of the report summarising the results are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail address: tineke@wrc.ccwr.ac.za.

The report is titled **Guidelines for the use of Peroxone and other oxidants for the treatment of eutrophic and coloured waters in South Africa** (WRC Report 443/1/97). (Overseas price, via surface mail: US\$ 20.)



The need for disinfection and oxidation of water is increasing as the volumes of municipal and industrial waste in the nearby rivers and lakes increase.

Interest in ozone as an alternative to chlorination has been on the rise in recent years. There are several reasons for this. First, the need for disinfection and oxidation of water is

increasing as the number of people municipalities has to serve grow and the volumes of municipal and industrial waste in the nearby rivers and lakes increase.

Second, technological advances have included the creation of more and more chemical compounds, elements of which invariably appear in the influent waters of drinking water treatment plants. Third it has come to light in recent years that chlorine based disinfectants, while providing disinfection, can combine with organic compounds to form materials which may present health hazards to humans and other life forms. Also, heavily chlorinated water has an associated taste which most people find undesirable.

The report says ozone reacts mainly in two ways: a direct oxidation route, which is usually very selective and an indirect oxidation route by entities resulting from the decomposition of ozone in water. Research has shown that the oxidising capacity of the ozonation process can be increased significantly by the addition of hydrogen peroxide. This combination known as Peroxone, promotes the production of high-energy, short-lived hydroxyl radicals from the accelerated decomposition of ozone by hydrogen peroxide - the indirect oxidation route. The hydroxyl radical attacks organic compounds indiscriminately and can oxidise some of them to carbon dioxide and water. Effective oxidation appears to be greatly dependent upon the applied ozone dosage, the peroxide/ozone ratio, the contact time and the composition of the raw water.

RESULTS

Generally, it was found that colour removal was obtained via the direct ozone reaction. However, colour removal could also be accomplished with hydroxyl radical oxidation, but not as effective as with ozone alone. Chlorine and chlorine dioxide could effectively remove colour whereas the use of hydrogen peroxide was ineffective in oxidizing humic and fulvic acids. It was also found that the presence of scavenging compounds such as carbonate ions had a detrimental impact on the radical oxidation process.

The oxidation of taste and odour compounds followed the radical oxidation pathway where the addition of hydrogen peroxide to ozone and ultra violet light led to enhanced removal of the compounds. In contrast to this, the use of conventional oxidants such as chlorine, chlorine dioxide and hydrogen peroxide were not effective in the removal

of these compounds.

In terms of trihalomethane (THM) formation, the use of ozone, Peroxone and chlorine dioxide are preferable over the conventional use of chlorine. Ultra violet irradiation, although not cost effective for oxidation purposes, produces no or very little THMs.

The difference in oxidation behaviour of phenol and dodecyl benzene sulphate (DBS) indicates that some prediction in whether a specific compound will be susceptible to radical pathway oxidation can be made. Where the direct oxidation reaction prevails (with phenol), the compound does not absorb ultra violet light, is not removed with hydrogen peroxide and effective oxidation with chlorine and chlorine dioxide takes place at low and high pH values. This situation is reversed when the radical pathway oxidation mechanism is preferred. With DBS the compound reacts favourably to ultra violet irradiation and hydrogen peroxide at high pH values oxidises the compound. In contrast with phenol, very little removal takes place when chlorine or chlorine dioxide is used at low pH values.

Guidelines for the Use of Peroxone
and other Oxidants for the
Treatment of Eutrophic and
Coloured Waters in South Africa

C J van der Walt

Report to the Water Research Commission
by the
Division of Water,
Environment and Forestry Technology,
CSIR

WRC Report No 443/1/97



In general it was found that ozone had no impact on improving flocculation.

The use of Peroxone in potable water treatment has a niche position and must have a specific objective such as the removal of a taste and odour compound or a pesticide. The implementation of an advanced oxidation process is also dependent on the type of unit

processes already installed in the treatment plant. If the treatment plant, for example, already makes use of an ozone plant or ultra violet irradiation, the extra cost for the dosing of hydrogen peroxide will be minimal.

COST

The process must be cost effective. To perform a cost analysis it will be important to determine dosages required as well as true costs associated with the specific oxidant such as discussed in chapter 6 of the report. Dosage determination should be conducted under controlled conditions and on a typical water sample to be treated. It is important that the destruction of specific micropollutants should not be investigated in the absence of background natural organic material. Because these natural organic materials are often present at concentrations several orders of magnitude greater than the micropollutant of interest and because these radical reactions are non-selective, the effectiveness of these processes for destroying specific micropollutants in such a natural water matrix should be determined.

HEALTH

The report says attention must be given to the health implications associated with the use of that specific oxidant. It was found that the use of ozone and Peroxone produces very little if any THMs on its own. However, the subsequent chlorination of the water can indeed form more THMs due to the breakdown of organics into compounds susceptible to THM formation. The use of chlorine dioxide for oxidation of organics resulted in low dosages to be used, as well as low formation of THMs and looks favourable. Apart from THM formation, one should also be aware of the possible effects of bromate formation when ozone is used as oxidant or disinfectant. Although this issue is still debatable, it cannot be disregarded.

Although the use of ultra violet irradiation and the combination thereof with hydrogen peroxide was also investigated, its commercial use can be limited due to high dosages required. Where ultra violet light is normally used for disinfection purposes with dosages in the region of 40 mWs/cm², the dosages needed for oxidation is several orders of magnitude more. This leads to high treatment costs

HYDROLOGY IN AFRICA

"People believe we will do things in South Africa that will demonstrate that Africa can succeed." — Deputy President Thabo Mbeki

In September 1996 the twelfth session of the Intergovernmental Council of the International Hydrological Programme (IHP) was held at the UNESCO headquarters. During this session, the following Resolution (XII-2) was adopted:

RESOLUTION XII-2

Formulation and implementation of a programme for the development of hydrology in Africa

According to this resolution the Intergovernmental Council of the International Hydrological Programme:

Recalls Resolution XI-8 of the eleventh session of the Intergovernmental Council of the IHP.

Recognises the efforts and achievements of UNESCO and WMO in the co-ordination of their programmes in hydrology and, in particular, in effective co-operation between the IHP and the OHP of WMO;

Notes the role of hydrologic information for sound water resources management and the need to improve knowledge at all levels concerning fundamental and applied aspects of the hydrological sciences in Africa as well as the urgent need of undertaking concrete and coherent actions to enable sub-Saharan Africa to make a constant qualitative and quantitative assessment of its water resources for its development;

Thanks the Director-General of UNESCO for the organization of the special conference 'Assises de l'Afrique' which provided an opportunity for the African countries to identify themselves the priorities of the African continent's development, as well as for the follow-up ensured to the above conference by the establishment of a special department 'Priority Africa' to develop the contribution of the organization to Africa;

Appreciates the efforts of the International Association of Hydrological Sciences (IAHS) in supporting the integration of the Association of African Hydrologists in the international scientific community;

Takes account of the difficulties encountered by the UNESCO Nairobi Office and in particular the Regional Hydrologist to fill the needs in the field of hydrology and water sciences due to the extent of the continent as well as the number of hydrological problems to address,

Appeals to member countries of the African region to support their hydrological services and IHP National Committees as well as realistic regional and subregional IHP co-operation;

Calls upon member countries and non-governmental organizations to support technically and financially the initiative to strengthen the development of hydrology in Africa;

Recommends to strengthen UNESCO's efforts in hydrology and water resources in Africa with the opening of a new post of Regional Hydrologist based in Western Africa to deal with the particular problems of their region and to allocate the appropriate funds for the activities;

Requests the Director-General of UNESCO to take appropriate measures for the explicit formulation and effective implementation of a programme for the development of water sciences in Africa, in particular:

□ development and strengthening of hydrology training courses in Africa and establishment of UNESCO Chairs in hydrology at African universities following an appropriate geographic and language distribution;

□ increasing synergy among African hydrologists through the strengthening of the Association of African Hydrologists, publication of an African Journal of Water Sciences and the organization

of periodic scientific meetings;

□ promoting participation of African hydrologists in regional and international scientific meetings by the development of a sustained and fruitful framework of co-operation with developed countries;

□ contribution to the mobilization of extrabudgetary funds to assist African countries in their national water resources assessment activities.

I have made the observation that besides South Africa the rest of Southern Africa was poorly represented at Rabat. And they were! The only other country representative I saw, was from Namibia. (Unfortunately she took my observation about poor representation somewhat personal. Barbara, I assure you we all appreciated your presence at the assembly and I publicly apologize for any misunderstanding in this regard.) However, Southern Africa comprises about 14 countries and if only two countries are present, I surely am entitled to call that poor representation!

One of the first actions I would plead for, is to draw up a list of hydrologists in Southern Africa and if the same were done in other regions of Africa, we could gradually start networking.

As a mission statement for the African hydrologist, I would suggest: "To promote the use of sound hydrological science in the development and management of water resources in Africa".

In conclusion I again would like to quote Deputy President Thabo Mbeki: "Essentially, our role is to lead by example and then to participate with the rest of the continent in terms of what is good for the continent - not participating as some sort of super-power but as an equal, sovereign, African state".

Hugo Maaren



News from the WRC Internet site

http://www-wrc.ccwr.ac.za

Welcome to the first issue of what will become a regular column in every issue of the SA Waterbulletin. In this column we hope to keep you informed about the latest developments and additions to the Internet site of the Water Research Commission (WRC). As always, your feedback, comments or suggestions for improvement will be welcomed.

WHERE TO FIND US

The address for the Internet site of the Water Research Commission is:

http://www-wrc.ccwr.ac.za

Please note the position of the hyphen!

WHAT YOU WILL FIND ON OUR SITE

The WRC hopes to develop its site to become the single point of entry to the country's main water-related information resources. While the development of the site is an on-going process, the following information is already available:

Opening page:

- Mission Statement of the WRC
- Street address, telephone and fax numbers
- Directions on where to find the offices of the WRC supported by a road map.

Get to know the WRC

- Details of who and what the WRC is, together with information on the way in which the organisation functions
- Names, photos and other details of WRC Commissioners (the board that controls the activities of the organisation)
- Names, e-mail addresses, photos, CV's (where available) and areas of responsibility of WRC Research Managers. Names of the individual secretaries are also given.

National Concerns

- Brief details on the issues covered by the eight National Concerns identified by the WRC for research.

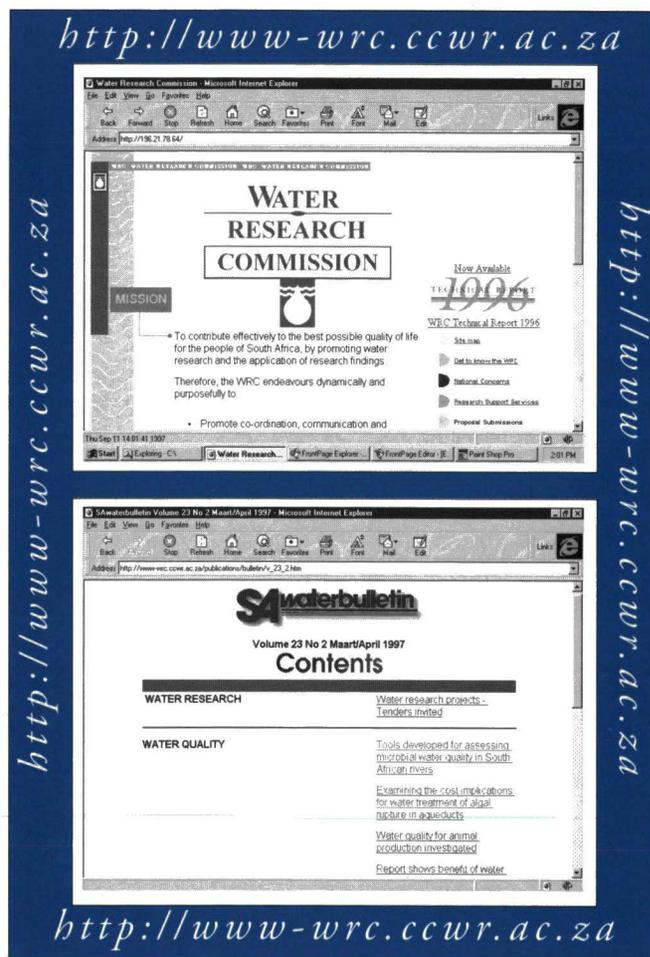
Research Support Services

Direct links to the research support services funded by the WRC:

- Computing Centre for Water Research (CCWR)
- Waterlit bibliographic database
- Water-related Research Projects Database

Events

- Titles, dates, venues and contact addresses for water-related conferences planned for local and overseas venues. Information is searchable according to geographical regions, date of event as well as abstract deadline dates.
- Details of local and international water-related training courses.



WRC Publications

- Full text of the 1996 WRC Technical Report (Annual Report)
- Full text of the March/April edition of the SA Waterbulletin. May/June edition to follow shortly.
- Abstracts of articles published in the first three editions of Water SA of 1997.
- List of titles of WRC Research Reports published in 13 subject fields. An electronic order form for research reports is also provided.

Water-related Institutions

Direct links are provided to the Internet sites of organisations grouped together in the following categories

- South African water-related sites
- Water research institutes and organisations worldwide
- Learned societies, scientific and professional associations worldwide

CONTACT PERSONS:

Martha Pretorius
mpretori@wrc.ccwr.ac.za

or Francette Myburgh
fmyburgh@wrc.ccwr.ac.za

Improving DAFF at a large water treatment plant

In 1988 the Rietvlei water treatment plant near Pretoria was upgraded and redesigned to accommodate dissolved air flotation and filtration (DAFF) in the same process unit. The reason for this drastic change was the eutrophication of the raw water which made conventional sedimentation before filtration impossible due to the high algal content of the water. Rietvlei is the first water treatment plant in South Africa that makes permanent use of DAFF at full-scale.

After operating for a number of years it was possible to identify areas where the operation of this process could possibly be improved. In a project funded by the Water Research Commission, three major areas were investigated namely:

- Flocculation requirements
- Rapid gravity filtration
- Recovery of filter backwash water

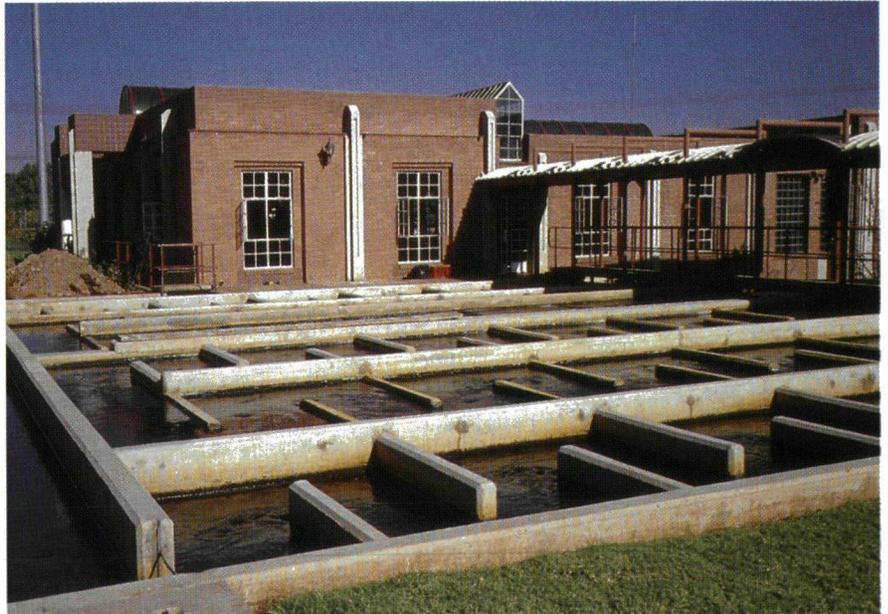
The researchers were JC van Beek and J Haarhoff from the Water Research Group at the Rand Afrikaans University.

According to the final report summarising the research results the objectives of the investigation regarding flocculation requirements were:

- to determine the utility of the Bratby reactor for testing eutrophic water; and
- to determine the influence of the primary coagulant, secondary coagulant and dosage selection in terms of the empirical aggregation and breakup constants, K_A and K_B in order to find an optimal operational point for flocculation.

The Argaman-Kaufman flocculation model with the Bratby reactor, provides a bench scale test method for determining the empirical aggregation and breakup constants, K_A and K_B for water with a synthetic kaolin suspension at any velocity gradient.

The researchers say the experimental



Rietvlei water treatment works.

method for the Bratby reactor was adapted to suit the conditions for algae-laden waters and a series of bench scale tests were conducted for a range of secondary coagulant types.

Full-scale flocculation tests were also conducted to compare the bench-scale predicted aggregation and breakup constants with that obtained in the baffled flocculation channel.

The results indicated that:

- flocculation conditions in the baffled flocculation channel can be predicted satisfactorily with the use of the Bratby reactor and the Argaman/Kaufman flocculation model;
- flocculation can be significantly improved with the aid of a non-ionic polyelectrolyte.

The effectiveness of rapid gravity filters in the removing of suspended matter as a final clarifying process after flocculation and sedimentation has undergone noteworthy improvement over the last few years. This improvement is due to both a deepening of the knowledge and

understanding of filtration mechanisms and technical improvement such as multimedia filtration.

Rietvlei water treatment plant has ten rapid gravity deep-bed filters. The filters are unusual in that they are combined with dissolved air flotation. The two processes are combined in the same tank and are called the DAFF (Dissolved Air Flotation and Filtration) process. The original treatment plant had four settling tanks and six filters which were converted into ten DAFF units during 1988. The filters for the DAFF units consisted of homogeneous layers of sand (0,70 mm effective size) and 880 mm depth. The sand is supported on thin layers of gravel and grit to prevent the sand from leaking into the pipe lateral underfloor system. Each filter has an effective area of 22,5 m². The theoretical rate of filtration then equals 177,8 m/d at full production.

The Rietvlei water treatment plant initially was experiencing filter runs as short as 14 hours while in full production (40 Ml/d). As an experiment the top 150 mm of sand of one of the deep-bed sand filters was replaced with fine coal

and the latter was later replaced with anthracite. This eventually led to the replacement of the top layer of seven of the other nine filters with anthracite over the period from June 1990 to December 1992. Two filters are still operated with sand only.

Practical experience at the plant indicated that the filter run lengths were indeed improved. During this investigation three questions were addressed:

- How much was the production improved?
- Was the benefit of longer run lengths due to multimedia filtration economical in terms of production (m/run) on this DAFF plant?
- Were the multimedia filters at this DAFF plant adequate in terms of quality and breakthrough?

The quality parameters used to evaluate the final water for the dual-media filters were:

- turbidity
- Fe
- UV adsorption at 254 nm

These parameters and the head loss were monitored for time spans of initially 36 hours and later 48 hours. At first two filters (one single and one dual-media) were monitored in parallel. This created operating problems and failures on the measuring apparatus and much data had to be disregarded. It was then decided to monitor one filter at a time.

The result of this monitoring process can be summarized as follows:

- Actual performance data has proved that production increases of 39 per cent on average can be achieved at Rietvlei water treatment plant with the use of dual-media filtration. The percentage increase is further related to the production in the sense that high production rates (m/run) results in a higher increase and vice versa.
- The use of dual-media filtration at Rietvlei water treatment plant has no adverse affect on the quality of the final effluent.
- Dual-media filters in use at Rietvlei water treatment plant can safely be

operated with head loss being the indicator for backwashing.

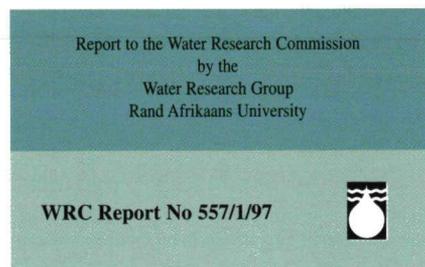
- It is recommended that filter run lengths should not exceed 22 hours.

At Rietvlei, the option to recirculate the filter backwash water was made available during the design and construction of the upgrading of the plant. Two settling tanks with a sludge retention tank and recirculation pumps were installed for the purpose of recirculation of filter backwash water. The recirculation option can still be bypassed and the filter backwash water is then released into the Hennops River which runs into Centurion Lake and eventually into Hartbeespoort Dam.



Optimization of Combined Flotation and Filtration at a Large Water Treatment Plant

C J van Beek • J Haarhoff



The problem with the recovery of filter backwash water on a DAFF plant with highly eutrophic raw water is twofold:

- filter backwash water comprises of both suspended material from the float layer on the surface of the filters (due to dissolved air flotation) and the material trapped in the filter bed (due to rapid filtration). Due to the difference in density between suspended material (from the float layer) and suspended matter (from filter), the filter backwash water settles very slowly;
- some of the air bubbles from the flotation process is trapped in the float layer which, if not completely removed, further impedes settling of the backwash water.

According to the report the purpose of this section of the study was:

- to increase the recirculation capacity of the backwash recovery system through chemical dosing of the filter backwash water;
- to select a coagulant for this purpose;
- to determine the optimum coagulant dosage, and
- to verify the improvement in settling characteristics caused by the coagulant addition.

A chemical dosing unit was installed in the filter gallery just upstream of the outlet to the backwash water settling tanks. The effect of various coagulants were tested by taking samples from the settling tanks at different heights and times. These were then analyzed for turbidity and settling curves were produced showing the percentage turbidity removed with time for each type of coagulant.

The results can be summarized as follows:

- Chemical dosing can reduce settling times, resulting in a reduction in minimum wash cycle lengths.
- Chemical dosing of DAFF filter backwash water have little benefit for settling times longer than 50 minutes with average settling depths of 1,35 m.
- A combination of inorganic and organic coagulants (typically Ferrifloc 1820) gives the best settling results after 25 minutes of settling.
- It is recommended that the filter backwash water at Rietvlei be chemically dosed with 34 mg/l FeCl₃ and recycled on a permanent basis.

Copies of the report entitled **Optimization of combined flotation and filtration at a large water treatment plant** (WRC Report 557/1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order address: tineke@wrc.ccwr.ac.za. Overseas price, inclusive of surface mail: US\$ 20.

Neutralising acid mine water with limestone - underground

A study funded by the Water Research Commission demonstrated that underground mine water can be neutralised effectively with limestone in a fluidised bed reactor. The researchers, JP Maree, GJ van Tonder and P Millard from the Division of Water, Environment and Forestry Technology at the CSIR, say Iron(II), which reduces the rate of neutralisation, can be oxidised to iron(III) upstream of the neutralisation reactor.

They say that by using the fluidised bed reactor for limestone neutralisation, the main weaknesses of limestone (low reactivity, scaling of limestone particles in other systems such as limestone weirs or anoxic limestone drains) are overcome.

"The problem of long reaction time as a result of the low reactivity of limestone is solved in the fluidised bed reactor because an excessive amount of limestone is in contact with the acid water. Scaling of limestone particles with com-

pounds such as gypsum, ferric hydroxide or aluminium hydroxide is prevented by the attrition between particles under fluidised conditions. Sludge of higher density is also produced when compared to that of the conventional lime treatment process."

This study has demonstrated that limestone neutralisation of acid water in a fluidised bed reactor offers advantages over conventional neutralisation processes. It can be implemented on full scale after site-specific tests have been carried out to obtain design criteria for specific waters.

A report summarising the results of the study titled **Underground neutralisation of mine water with limestone** (WRC report 609/1/96) is available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order address: tineke@wrc.cwr.ac.za. (Overseas price, inclusive of surface mail: US\$ 15.)

Acidic effluents arise in the mining industry mainly from discarded overburden, slimes dams, sand dumps, underground workings and metallurgical plants. Limestone can be used to neutralise acid mine drainage, which results from the oxidation of sulphur containing minerals, such as pyrites. Pyrite oxidation occurs underground during or after mining activities and on surface in old mine dumps containing pyrites.

Acid water is neutralised with a discharge or recycle aim in mind. Acid water contributes to corrosion of pipelines and mineralisation of surface water. Neutralised acid water also contributes to surface water mineralisation. Acid water is generally detrimental to aquatic life and has a negative aesthetic impact on rivers and streams.

Lime neutralisation of acid water is widely applied to meet legislative requirements regarding discharge of effluent into receiving waters. Lime and chemicals like sodium hydroxide and sodium carbonate have the disadvantage that they require accurate dosing to prevent under or over application. This is difficult to achieve underground in mining operations, resulting in water with low or high pH values (3 to 10 respectively) to be pumped through the vertical mine water pipelines. This may

result in either corrosion as a result of low pH, or gypsum scale formation when lime is dosed as a result of the high calcium concentration. Since large amounts of lime are required, neutralisation of effluents is a costly operation.

The CSIR, in collaboration with the WRC, has developed a fluidised bed neutralisation process which uses limestone or dolomite as the neutralising agent. This effectively overcomes the dosing problem as limestone will only dissolve as long as the water is undersaturated with respect to calcium carbonate. Dissolution usually stops at a pH between 6 and 7.

BENEFITS

The benefits associated with limestone neutralisation include:

- Direct savings on the purchase cost of neutralisation material.
- Simplified pH-control as limestone and dolomite dissolution occurs mainly at pH-values below 7. Since the flow rate of underground mine water may vary by a factor of 10, lime/soda ash systems can only function well if its dosing rates are adjusted accordingly. The fluidised bed limestone neutralisation process is not affected by changes in flow rate as the acid feed water is bled into the recycle stream which

passes through an excessive amount of limestone.

- Minimisation of material wastage which would occur as a result of overdosage (due to pH-solubility relationship referred to above).
- Elimination of hazardous chemical usage for neutralisation (limestone/dolomite is easy and safe to handle).
- Simple bulk chemical storage facilities (the raw materials are not readily soluble in neutral water).
- Utilisation of equipment at existing lime neutralisation plants.

According to the report the development stage of the limestone neutralisation process had been completed prior to this study, but further development was required to make the process suitable for the underground treatment of acid water.

OBJECTIVES

The aims of the investigation were to:

- Obtain design criteria for iron(II) oxidation prior to neutralisation to make the process suitable for the neutralisation of iron(II)-containing water, which is typically the case with acid mine drainage and underground mine water.
- Modify the process to make it suit-

able for the underground neutralisation of acid mine water. The major limitations to any underground process are lack of space and means of transport of raw material. A specific aspect to be investigated was the shape of the reactor required to fit into the space available underground.

- Demonstrate that underground mine water can be neutralised with limestone in the fluidised bed limestone neutralisation process.
- Determine the economic feasibility of the fluidised bed limestone neutralisation process.

MATERIALS AND METHODS

The following studies were carried out:

- Laboratory-scale batch studies to determine the effect of iron, oxygen and bacterial concentrations and temperature on the rate of oxidation.
- Continuous laboratory-scale studies to evaluate the efficiency of the column-shaped fluidised bed, with water recycled through a clarifier to minimise washout of limestone particles.
- Pilot-plant studies at capacities of up to 7 kl/h underground in a gold mine for a continuous period of 30 days to determine the contact time required between the acid water and the limestone, chemical composition of feed and treated water, and the economic feasibility of the fluidised bed limestone neutralisation process.

RESULTS

The findings from the study can be summarised as follows:

- **Iron(II)-oxidation.** A biological process upstream of the neutralisation step was successfully used to oxidise iron(II) to iron(III). Limestone neutralisation is more efficient when iron(II) is oxidised to iron(III) upstream of the neutralisation stage. The reason is that iron(II) passes through the limestone neutralisation reactor unchanged due to its relatively high solubility. The volumetric reaction rate was 5,5 g Fe/l.d at an iron concentration of 5 g/l Fe, a dissolved oxygen concentration of 8 mg/l, and a temperature of 25 °C. The required retention time of 22 h for iron(II) oxidation might be too long for

application underground due to limited space. For waters with high iron(II) concentrations (greater than 200 mg/l Fe), it is recommended that iron(II) oxidation be applied at surface level. This is still acceptable from a practical point of view. By neutralising only free acid and acid associated with iron(III) underground, the pH of the water could be raised to above 5.5, where the corrosivity of the water is significantly less. The underground mine water tested in this study contained only 5 to 20 mg/l Fe(II), and no pretreatment for iron(II) oxidation was therefore required.

- **Water quality.** The limestone neutralisation process improves the quality of the water by the complete removal of free acid and acid associated with Fe(III). Sulphate is removed up to the point where the water is saturated with calcium sulphate. The pH of the water can be increased from less than 3 to more than 7, while the initial acidity, iron and uranium are removed by 97 per cent (400 to 12 mg/l as calcium carbonate), 95 per cent (20 to < 1 mg/l Fe) and 83 per cent (1 100 to 190 mg/l U) respectively. The alkalinity of the treated water is generally greater than 120 mg/l (as calcium carbonate). In the case of a strong acid solution the pH can be increased from 1,1 to 7,0, the acidity reduced from 18,4 to almost 0 g/l (as calcium carbonate), and sulphate from 13,5 to 1,3 g/l.

- **Kinetics.** The rate of limestone neutralisation is influenced by the following factors:

- Surface area of limestone particles. The surface area is a function of the type of limestone (amorphous or crystalline) and particle size.

- Chemical composition of limestone. The higher the magnesium content, the slower is the rate of neutralisation.

- Chemical composition of the acid water. The rate of neutralisation is fast for waters containing mainly free acid and iron(III). The neutralisation rate is lower when iron(II), aluminium or magnesium is present.

- Concentrations of acid and limestone.

- **Contact time.** A requirement for underground neutralisation of acid water with limestone is that equipment should fit into the available space,

which is at best limited. A column-shaped fluidised bed reactor, with water recycled through a clarifier to minimise washout of limestone particles was evaluated for this purpose. For the water under investigation, it was found that a contact time of 10 min between mine water and limestone can be used for design purposes. The required contact time, however, is a function of the surface area of the limestone and the chemical composition of the mine water.

- **Limestone utilisation.** With the column-shaped fluidised bed reactor, it was found that all the acid fed is neutralised, and stoichiometrically, the equivalent amount of limestone is consumed.

- **Sludge removal.** Precipitates, such as gypsum and ferric hydroxide, and limestone impurities are washed out from the fluidised bed reactor and separated from the water in a settler downstream of the neutralisation stage. Should certain impurities, such as sand in the case of limestone deposits near the sea shore, accumulate in the reactor, it can be discharged from the bottom of the reactor on a periodic basis.

- **Economic feasibility.** Chemical savings of 66 per cent can be achieved when the cost of limestone and lime amounts to R100/t and R400/t respectively. For the neutralisation of 164,25 t/d of acid (as calcium carbonate), limestone cost amounts to R0,06/kl, R0,47/kl and R1,47/kl when waters with acid contents of 0,45 g/l (gold mine water), 3,60 g/l (coal mine drainage) and 11,25 g/l (Uranium raffinate) (all contributions expressed in g/l calcium carbonate) is treated, respectively. The corresponding capital and construction cost amounts to R1 400 000/(M/d), R1 500 000/(M/d) and R2 300 000/(M/d), respectively, and the corresponding running cost (including chemicals, electricity, labour and capital redemption costs) to R0,23/kl, R1,60/l and R3,31/kl, respectively.

Oxidation of iron(II)-rich water is required for iron(II) concentrations greater than 0,2 g/l. The cost figures shown above include the oxidation cost. The capital and construction costs for the iron(II) oxidation stage amounts to R458 000/(M/d) and R730 000/(M/d) for coal mine drainage and Uranium Raffinate, respectively.

SA WATERKALENDER

The Water Research Commission is placing this calendar in order to assist with the co-ordinating of water events in South Africa.

You are invited to send information about conferences, symposia or workshops to the SA Waterbulletin.

Address:
The Editor,
SA Waterbulletin,
P.O. Box 824,
0001 Pretoria
Tel (012) 330-0340
Fax (012) 331-2565

Legend:

- An SA Water Event arranged for these dates.
- 2nd SA Water Event scheduled for these dates.
- 3rd SA Water Event scheduled for these dates.

See conferences and symposia pages for events.

Die Waternavorsingskommissie plaas hierdie kalender om te help met die koördinerings van watergebeurtenisse in Suid-Afrika.

Alle belanghebbendes word uitgenooi om inligting aan SA Waterbulletin te stuur.

Adres:
Die Redakteur
Posbus 824
0001 Pretoria
Tel: (012) 330-0340
Fax: (012) 331-2565

Gids:

- Een SA Watergeleentheid vir hierdie dae.
- 'n Tweede SA Watergeleentheid vir dié datums.
- 'n Derde SA Watergeleentheid vir dié datums.

Sien Konferensies- en Simposiumbladsy vir aangeduide geleenthede.

1997

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SOUTHERN
AFRICA

1997

SEWAGE PLANTS

OCTOBER 6 - 10

A post-graduate training course in water utilisation: Operation of small water purification and sewage plants will take place in Pretoria.

Enquiries: The Head, Water Utilisation Division, University of Pretoria, Pretoria 0002. Fax: (012) 43-6683. E-mail: dtol-h@fanella.ee.up.ac.za

MEMBRANE
TECHNOLOGY

OCTOBER 21 - 24

The second WISA-MTD workshop and seminar will be held at the Aventura Badplaas resort in Mpumalanga. Theme: Membranes in your industry.

Enquiries: Dr Ed Jacobs (secretary - WISA-MTD), Institute of Polymer Science, University of Stellenbosch, PO Matieland, Stellenbosch 7602. Fax: (021) 808-4967. Tel: (021) 808 3178. E-mail: epj@land.sun.ac.za

HYDRAULICS

NOVEMBER 5 - 7

The third in the series of international River Flood Hydraulics conferences will be organised by HR Wallingford in partnership with the University of Stellenbosch at Stellenbosch. Topics to be covered include flood hydraulics and hydrology, management of developments on flood plains, flood control, sediment transport and river morphology, flow measurement: social, economic and environmental aspects.

Enquiries: Prof A Rooseboom, University of Stellenbosch. Tel: (021) 808-4353. Fax: (021) 808-4361.

DAM DESIGN

NOVEMBER 3 - 4

A course on the design of smaller dams will be offered under the auspices of SANCOLD at the University of Stellenbosch.

Enquiries: Prof A Rooseboom, University of Stellenbosch. Tel: (021) 808-4353. Fax: (021) 808-4361.

HYDROLOGY

NOVEMBER 17 - 19

The SANCIAHS/SAICE '97 conference will be held at the University of Pretoria. Theme: Integrated hydrological sciences for sustainable water resources management in Africa.

Enquiries: Ms Gerda Kruger, Water Research Commission, PO Box 824, Pretoria 0001. Tel: (012) 330-0340. Fax: (012) 331-2565. E-mail: gerda@wrc.ccw.ac.za

WATER & SANITATION

DECEMBER 1 - 5

A conference on standard setting, quality control and coordination for training in the water and sanitation sector will be held in the Gauteng Province. **Call for papers.**

Enquiries: The Coordinator: ITN Africa Conference, PO Box 95557, Waterkloof, Pretoria 0145. Tel/Fax: (012) 46-5453.

1998

CEMSA '98

FEBRUARY 9 - 11

An international conference and exhibition on Integrated Environmental Management (IEM) in South Africa will be held in East London.

Enquiries: Professor OS Fatoki, University of Fort Hare, Analytical Chemistry, Private Bag X1314, Alice 5700. Tel: 404-22094. Fax: 404-31643. E-mail: FATOKI@UFHCC.UFH.AC.ZA

WISA '98

MAY 4 - 7 1998

The biennial conference and exhibition of the Water Institute of Southern Africa (WISA) will be held in Cape Town. **Call for papers.**

Enquiries: Conference Planners, PO Box 36782, Menlo Park 0102. Tel: (012) 348-4493. Fax: (012) 348-1563. E-mail address: wissing@iafrica.com

WASTECON '98

OCTOBER 13 - 15

This international conference will be held at the World Trade Centre in Kempton Park and is intended to explore new perspectives in waste management, particularly those applicable to the southern African region.

Topics will include management aspects such as auditing, reporting, monitoring, environmental management systems, legal institutional and policy developments, alternative and appropriate technologies and public participation. **Call for papers.**

Enquiries: Piet Theron or Sonja Havenga at the Institute for Waste Management. Tel: (011) 787-1151. Fax: (011) 787-1086.

OVERSEAS

1997

LANDFILL

OCTOBER 13 - 17

The sixth International Landfill Symposium will be held in Cagliari, Sardinia, Italy.

Enquiries: Ms Anne Farmer, CISA - Environmental Sanitary Engineering Centre, Via Marengo 34 - 09123 Cagliari (Italy). Tel: +39-70-271652. Fax: +39-70-271371. E-mail: cos-sur@vaxca3.unica.it

DRINKING WATER

OCTOBER 16 - 19

An international conference on the management of drinking water resources will take place in Madras, India.

Enquiries: M Mariappan, Organising Secretary, Central Leather Research Institute, Adyar, Madras 600 020, India. E-mail: root@niclai.ernet.in Fax: 91 044 4911589. Tel: 91 044 4916351.

WEFTEC '97

OCTOBER 18 - 22

The American Water Environment Federation's 70th annual conference and exposition will be held in Chicago, Illinois USA. Enquiries: WEFTEC '97 Program, 601 Wythe Street, Alexandria, Virginia 22314-1994 USA. Tel: 1-703-684-2452 Fax: 1-703-684-2471.

OZONE

OCTOBER 26 - 31

The 13th world congress of the International Ozone Association will be held in Kyoto, Japan.

Enquiries: Congress Corporation. Tel: +81 (6) 454 3740. Fax: +81 (6) 454 4711.

LAKES

OCTOBER 27 - 31

The 7th ILEC international conference on the conservation and management of lakes will be held in San Martin de los Andes, Argentina.

Enquiries: Instituto Nacional de Ciencia y Tecnica Hidricas, CC No 46, 1802 Aeropuerto Ezelza, Prov. de Buenos Aires, Argentina. Tel: +54 1 480 0867. Fax: +54 1 480 0094.

IWEX '97

The international water and effluent treatment exhibition, IWEX '97, will be held in Birmingham, UK.

Enquiries: Tom Tebbat, Exhibition Director, Turret Group Plc, 171 High Street, Rickmansworth, Herts, WD3 1SN, United Kingdom. Fax: +44 1932 221346. Tel: +44 1932 228577.

1998

WATER QUALITY

FEBRUARY 25 - MARCH 1

The first international specialised conference on water quality and its management will be held in New Delhi, India.

Enquiries: CVJ Varma, Central Board of Irrigation & Power, Malcha Marg. Chanakyapuri, New Delhi 110021, India. Tel: +91 11 3015984. Fax: +91 11 3016347. E-mail address: cbip@cbipdel.uunet.in

WATER MANAGEMENT

MARCH 11 - 13

A symposium to evaluate and discuss the technological, economical, social and ecological feasibility and the implementation of sustainable urban water management systems.

Enquiries: Dr Hans Aalderink, Wageningen Agricultural University, Dept of WKAO, PO Box 8080, NL-6700 DD Wageningen, The Netherlands. Fax: +31 317 484411. E-mail: Hans.aalderink@wkwa.wkwa.wa.u.nl

ACTIVATED SLUDGE

MARCH 16 - 18

A seminar on the modelling and microbiology of activated sludge processes will be held in

Kollekole, Denmark.

Enquiries: MiaCon, Dept of Environmental Science and Engineering, Building 115, Technical University of Denmark, DK-2800 Lyngby, Denmark. Tel +45 4525 1613. Fax: +45 4593 2850. E-mail: bn@imt.dtu.dk

STORM DRAINAGE

MAY 4 - 6

A conference on innovative technologies in urban storm drainage (Novatech 1998) will be held in Lyon, France.

Enquiries: GRAIE, BP 2132, 69603 Villeurbanne Cedex, France. Tel: +33 472 438368. Fax: +33 472 449277. E-mail: graie@urgc-hu.insa-lyon.fr

CHLORINATED COMPOUNDS

MAY 18 - 21

The first international conference on remediation of chlorinated and recalcitrant compounds will be held in Monterey, California, USA.

Enquiries: The Conference Group, 1989 West Fifth Avenue Suite 5, Columbus, Ohio 43212-1912 USA. Tel: 614-424-5461. Fax: 614-488-5747. E-mail: 102632.3100@compuserve.com

ECWATECH-98

MAY 25 - 30

The third international congress and exhibition on water, ecology and technology will take place in Moscow, Russia.

Enquiries: The organising committee, PO Box 173, Moscow 107078, Russia. Tel/fax: +7 (095) 207 6360 E-mail address: ecwatech@sibico.msk.ru

MEMBRANE SCIENCE

JUNE 9 - 12

An international conference on membrane science and technology (ICMST '98) will be held in Beijing, China.

Enquiries: Mrs Yanqiao Shi, ICMST'98, c/o Institute of Chemistry, Chinese Academy of Sciences, Zhongguancun, Beijing 100080, China. Fax: +86-10-62569564 OR: 62559373.

IAWQ

JUNE 21 - 26

The 19th biennial conference of the International Association on Water Quality will be held in Vancouver, BC Canada.

Enquiries: IAWQ, Duchess House, 20 Mason Yard, Duke

St., St James's, London SW1Y 6BU, United Kingdom. Tel: 44 (0) 171-839 8390. Fax: 44 (0) 171-839 8299.

GROUNDWATER

JULY 12 - 16 1998

An international conference with the theme Future groundwater resources at risk will be held in Changchun, China.

Enquiries: Professor Lin Xueyu, Changchun University of Earth Sciences, Changchun, Jilin 130 026, China. Fax: 86 431892 8327.

FOG COLLECTION

JULY 19 - 24

The first international conference on fog and fog collection will be held in Vancouver, Canada. Scientific sessions will include: Fog physics and chemistry; Fog-vegetation interactions; Fog deposition to temperate forests; Fog deposition to tropical forests; Fog contributions to sub-surface water supplies; Construction and use of fog collectors; Measurement of fog fluxes and collection rates and the Assessment of the role of fog in specific ecosystems.

Enquiries: Dr Robert S Schemenauer, Conference chair, Environment Canada. Tel: (416) 739-4606 Fax: (416) 739-4211. E-mail: robertss@armph3.dow.on.doe.ca

BRACKISH WATER

JULY 23 - 24

An international workshop on the use of saline and brackish water for irrigation - implications for the management of irrigation, drainage and crops will be held in Bali, Indonesia. **Call for papers.**

Enquiries: ICID Workshop, Dr R Ragab, Institute of Hydrology, Wallingford Oxon. OX10 8BB UK. Tel: +44 1491 692303. Fax: +44 1491 692424. E-mail: R.Ragab: ua.nwl.ac.uk

CLIMATE & WATER

AUGUST 17 - 20

The second international conference on climate and water will be held in Espoo, Finland.

Enquiries: Risto Lemmela, HUT/Water Res. Eng., Huhtatie 12, 04300 Tuusula, Finland. Tel: +358 9 275 3835. Fax: +358 9 451 3827. E-mail: rlemmela@ahiti.hut.fi

HYDRO-INFORMATICS

AUGUST 24 - 26

This is the third in a series of conferences held every two years on all aspects of data and information management related to hydrology. It will be held in Copenhagen, Denmark.

Enquiries: Dr Vladan Babovic, Danish Hydraulic Institute (DHI), Agern Alle 5, 2970-DK Horsholm, Denmark. Tel: +45 45 179133. Fax: +45 45 762567. E-mail: vmb@dhi.dk

IAHR

AUGUST 26 - 28

The biennial conference of the International Association of Hydraulic Research (IAHR), African Division, is to be held in Hurgada on the Red Sea, Egypt. Theme: Coping with water scarcity. Topics: Integrated management in arid zones; Environmental impact; Surface and groundwater hydraulics and Alluvial hydraulics.

Enquiries: Hydraulics Research Institute, Delta Barrage 13621, Egypt. Fax: (202) 218-9539 or Professor D Stephenson, PO Box 277, WITS 2050. Fax: (011) 403-2062.

WETLANDS

SEPTEMBER 98

A conference on wetland systems for water quality control will be held in Sao Paulo, Brazil.

Enquiries: Dr Samia Maria Tauk-Tornisielo, Centro de Estudos Ambientais/UNESP, Avedida 24-A, 1515 Bela Vista, CEP 13506-900, Rio Claro (SP), Brazil. Tel: +55 019 534 7298. Fax: +55 019 534 2358. E-mail: cea@life.ibrc.unesp.br

WATERSHED MANAGEMENT

SEPTEMBER 7 - 10

An international symposium on comprehensive watershed management (ISWM-'98) will be held in Beijing, China. **Call for papers.**

Enquiries: Mr Tan Ying, IRTCES, PO Box 366, Beijing 100044, China. Tel: +86-10-68413372. Fax: +86-10-68411174. E-mail: irtces@public2.bta.net.cn

WASTEWATER TREATMENT

SEPTEMBER 14 - 16

A conference on advanced wastewater treatment, recycling and reuse will be held in Milan, Italy.

Enquiries: ATW98, Scientific

Secretariat, DIIAR - Sezione Ambientale, Piazza Leonardo da Vinci 32, 20133, Milano, Italy. Tel: +39 2 23996416. Fax: +39 2 23996499. E-mail: milano98@amb1.amb.polimi.it

ENVIRONMENT-WATER

SEPTEMBER 16 - 18

The first inter-regional conference on environment-water - innovative issues in irrigation and drainage will take place in Lisbon, Portugal. **Call for papers.**

Enquiries: Portuguese National Committee of ICID, Instituto da Agua, Av. Almirante Gago Coutinho 30, 1000 Lisboa, Portugal. Fax: 351-1-8473023. E-mail: lenamar@inag.pt

UDM '98

SEPTEMBER 21 - 24

A conference with the theme Developments in urban drainage will be held in London, UK. This conference is the fourth in a series of specialist conferences on aspects of urban drainage.

Enquiries: Dr D Butler, Imperial College of Science, Technology and Medicine, Dept of Civil Engineering, Imperial College Road, London SW7 2BU, UK. Tel: +44 171 594 6099. Fax: +44 171 225 2716. E-mail address: d.butler@ic.ac.uk

TISAR '98

SEPTEMBER 21 - 25

The third international symposium on artificial recharge of groundwater will be held in Amsterdam, the Netherlands.

Enquiries: Symposium Secretariat, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 72 5899062. Fax: +31 72 5899040. E-mail: R.R.Kruize@inter.nl.net

GROUNDWATER

SEPTEMBER 21 - 25

An international conference and special workshops on groundwater quality: remediation and protection (GQ 98) will be held in Tübingen, Germany.

Enquiries: Conference Secretariat GQ'98, c/o Lehrstuhl für Angewandte Geologie, Sigwart str 10, D-72076 Tübingen, Germany. Tel: +49 (0) 7071-297-4692 OR: 297-6468. Fax: +49 (0) 7071-5059. E-mail address: mike.herbert@uni-tuebingen.de

INTRODUCTORY COURSE IN WATER MICROBIOLOGY

18 - 21 November 1997

To be held at the Division of Water,
Environment and Forestry Technology,
CSIR, Pretoria

PURPOSE

The purpose of this course is to provide a practical approach where participants will be trained in the basic concepts of health-related water microbiology. The course will include both practical (60%) and theoretical (40%) aspects.

WHO SHOULD ATTEND

The course is aimed at people working in the water industry who require knowledge about basic techniques for the microbiological analysis of water. Industry, municipalities, government departments, water boards are among the bodies who may find such a course useful.

ATTENDANTS

A maximum of 10 - 12 attendants will be allowed to ensure adequate personal attention for each one.

COURSE CONTENTS

Attendants will be trained in the basics of water microbiology. These include:

- ◆ Detection and analyses of faecal indicators of pollution (Standard plate count; Total coliform; Faecal coliform; Faecal streptococci/Enterococci; Coliphage and the confirmation of *Escherichia coli*).
- ◆ Interpretation and reporting of results.
- ◆ Demonstrations on the detection of other pathogens in water: Viruses; Parasites; Legionella; Bio-assays for toxicity and Ames mutagenicity test.
- ◆ Quality control procedures.
- ◆ Laboratory safety.

COST

R3 000 per person, excluding VAT. All teas and lunches are included in the cost of the course.

COURSE MANUAL

A course manual will be supplied to all participants.

ACCOMMODATION

Accommodation and the cost of travelling to and from the CSIR are not included in the price.

CONTACT PERSON

Mrs Pauline Coubrough
Tel: (012) 841-3952
Fax: (012) 841-4785

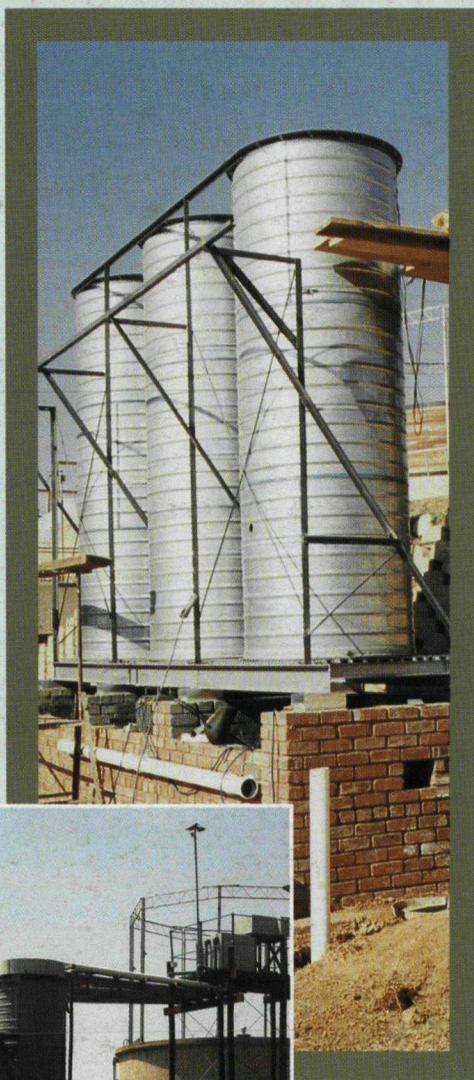


NOTE

- ◆ A detailed course programme will be sent on request.
- ◆ A minimum of seven participants is required for the course to be presented.
- ◆ Participants are welcome to bring their own laboratory coats.

TECHNOLOGY TRANSFER WORKSHOP ON BIOFILTRATION AND SECONDARY CLARIFICATION

This workshop will transfer the latest technology with respect to biofiltration, both in carbon and ammonia removal. The workshop will cover both international experience in this field as well as local South African studies.



The workshop will also present a preview of the new IAWQ STR document on the theory, modelling, design and operation of secondary settling tanks.

The workshop will be presented by international and local specialists which include Dr DS Parker of USA, Prof Cloete of the University of Pretoria, Prof Ekama of the University of Cape Town and Dr André van Niekerk of Wates, Meiring and Barnard Consulting Engineers.

WHEN

4 - 5
November

WHERE

Helderfontein
Conference
Centre,
Kyalami

COST

R800,00
per person



ENQUIRIES AND REGISTRATION

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