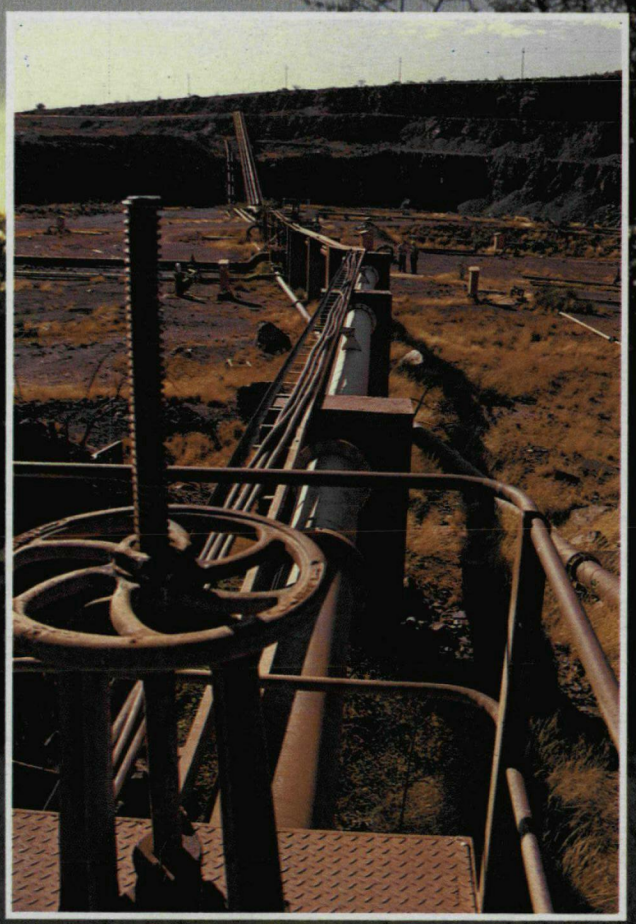
SA waterbulletin

VOLUME 12 No 3

AUGUSTUS/AUGUST 1986



SISHEN
Die waterdraer met 'n ystergreep

SLUDGE
New stabilisation process demonstrated

22–24 September 1986

simposium

anaërobe vertering

PROGRAMOORSIG

Die simposium sal uit lesing-, plakkaat- en besprekingsessies bestaan. Moontlike besprekingsonderwerpe sal insluit:

- Oorsig oor anaërobe vertering
- Ingenieursaspekte van die proses
- Prosesbeheer
- Rioolbehandeling
- Die behandeling van industriële uitvloeisels
- Ekonomiese aspekte van die proses
- Die vertering van landbou-afval
- Mikrobiologie van die verteringsproses
- Biochemiese aspekte
- Opberg en gebruik van biogas

Die reëlingskomitee onderhandel ook om enkele vooraanstaande nasionale en internasionale navorsers te betrek by die simposium.

KORRESPONDENSIE:

Alle korrespondensie en vorms met betrekking tot die simposium moet gerig word aan:

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Afdeling Nie-formele Onderwys
Posbus 4345
BLOEMFONTEIN 9300
SUID-AFRIKA
Tel: 051-70661 X 425
Teleks: 267666

LOKAAL EN DATUM VAN SIMPOSIUM

Die Anaërobe Verteringsimposium sal gehou word by die Universiteit van die Oranje-Vrystaat, Bloemfontein, Suid-Afrika.

VOORLOPIGE KOSTES:

Voorlopige kostes beloop ongeveer R80–R100 maar sluit nie verblyfkostes in nie.

Departement Mikrobiologie
Universiteit van Oranje Vrystaat
Bloemfontein

Nasionale Instituut
vir Waternavorsing
WNNR

SA waterbulletin

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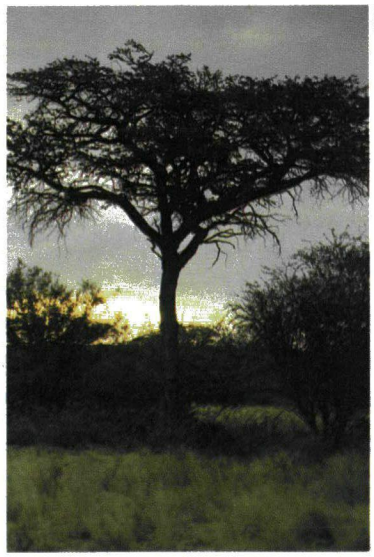

WRC

Kameeldoringbome by Kathu in die Noordwes-Kaap.

SA Waterbulletin **is a quarterly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organization established in 1971 by Act of Parliament.**

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Ed. Secretary: Rina Human

SA Waterbulletin **is 'n kwartaallikse tydskrif oor water en waternavorsing wat uitgegee word deur die Suid-Afrikaanse Waternavorsingskommissie (WNK), 'n statutêre organisasie wat in 1971 by Wet gestig is.**

Intekening is gratis. Stof in dié publikasie weerspieël nie noodwendig die oorwoë menings van lede van die WNK nie, en mag hergebruik word met erkenning van die bron.

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Asst-redaktrise: Marietta Theron
Red. sekretaresse: Rina Human

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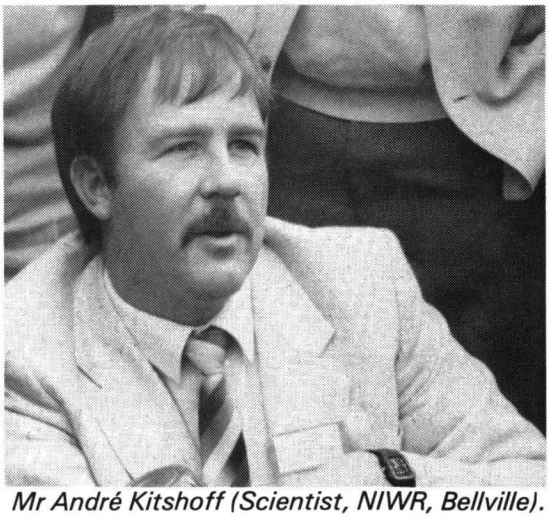
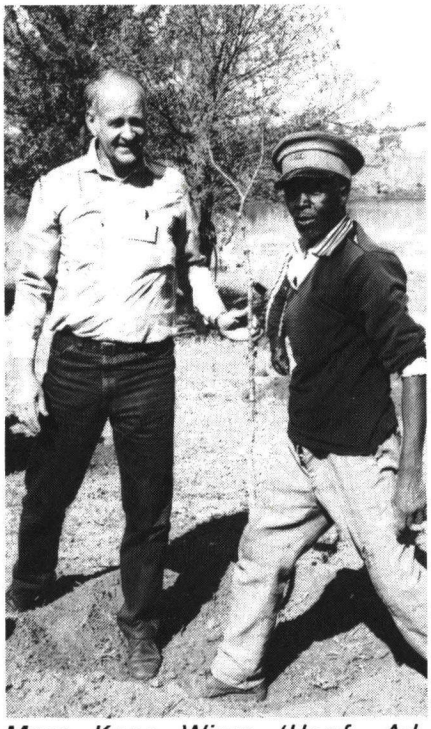


Mr André Kitshoff (Scientist, NIWR, Bellville).

Forced aeration stabilisation was the centre of attraction at a seminar and demonstration held at the NIWR in Bellville. The seminar was jointly presented by the WRC and the NIWR. For more information please read the article on page 6.

Dr GG Cillié and Mr D Holmes (BS Bergman and Partners)



Mnre Koos Wium (Hoof, Adviserende Dienste, Waterversorging, NIWN), Garason Sato (Werker by Montshiwa, Bophuthatswana).

(Regs): Drs Daan Toerien (Hoofdirekteur, NIWN), Herman Wiechers (Senior Adviseur, WNK).

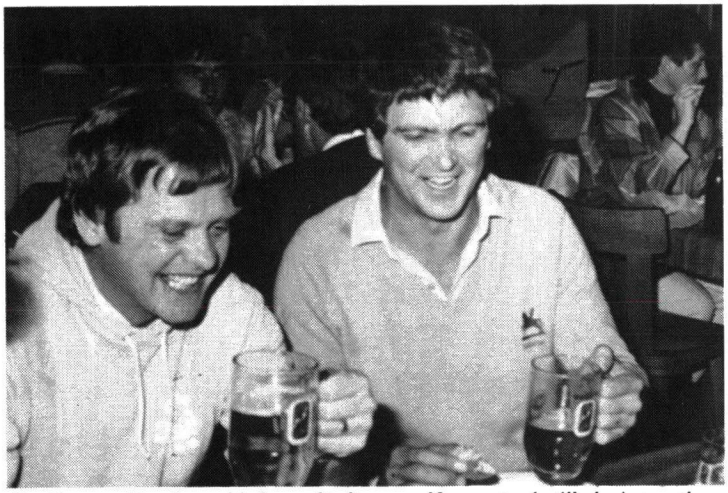
Skrywer Credo Mutwa.

Tydens 'n onlangse seminaar in Mmabatho het seminaargangers die geleentheid gehad om elkeen 'n boom by Montshiwa te plant. As bonus is hulle ook deur die skrywer van Indaba my Children, Credo Mutwa, toegespreek. 'n Artikel oor watervoorsiening in Bophuthatswana gedurende die droogte is op bladsy 12.

Die jaarlikse kongres van die Limnologiese Vereniging van Suidelike Afrika (LSSA), is vroeër vanjaar in Windhoek, SWA, gehou. Die tema was akwatiese ekosisteme in panne, riviere, vleilande en damme. Altesaam 35 referate en nege plakkaatvoordragte is aangebied.

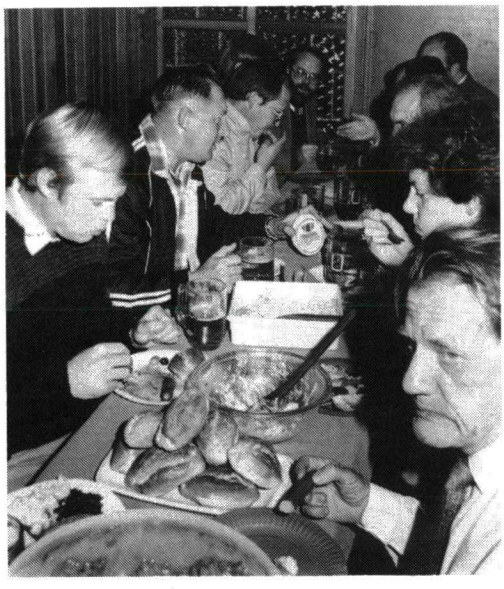
Na die kongres is besoek aan o.a. die Oostelike Nasionale Waterdraer en die Gobabeb ekologiese navorsingstasie in die Namibwoestyn afgelê. Lees ook die artikels op bladsye 14 en 24.

Professor Charles Breen van die Universiteit van Natal wat as die nuwe president van die LSSA verkies is.



Dr Bryan Davies, Universiteit van Kaapstad, (links) en dr Danny Walmsley WNNR.

(Bo en links onder) Afgevaardigdes geniet die Suidwesters se gasvryheid . . . en die Windhoek Lager!

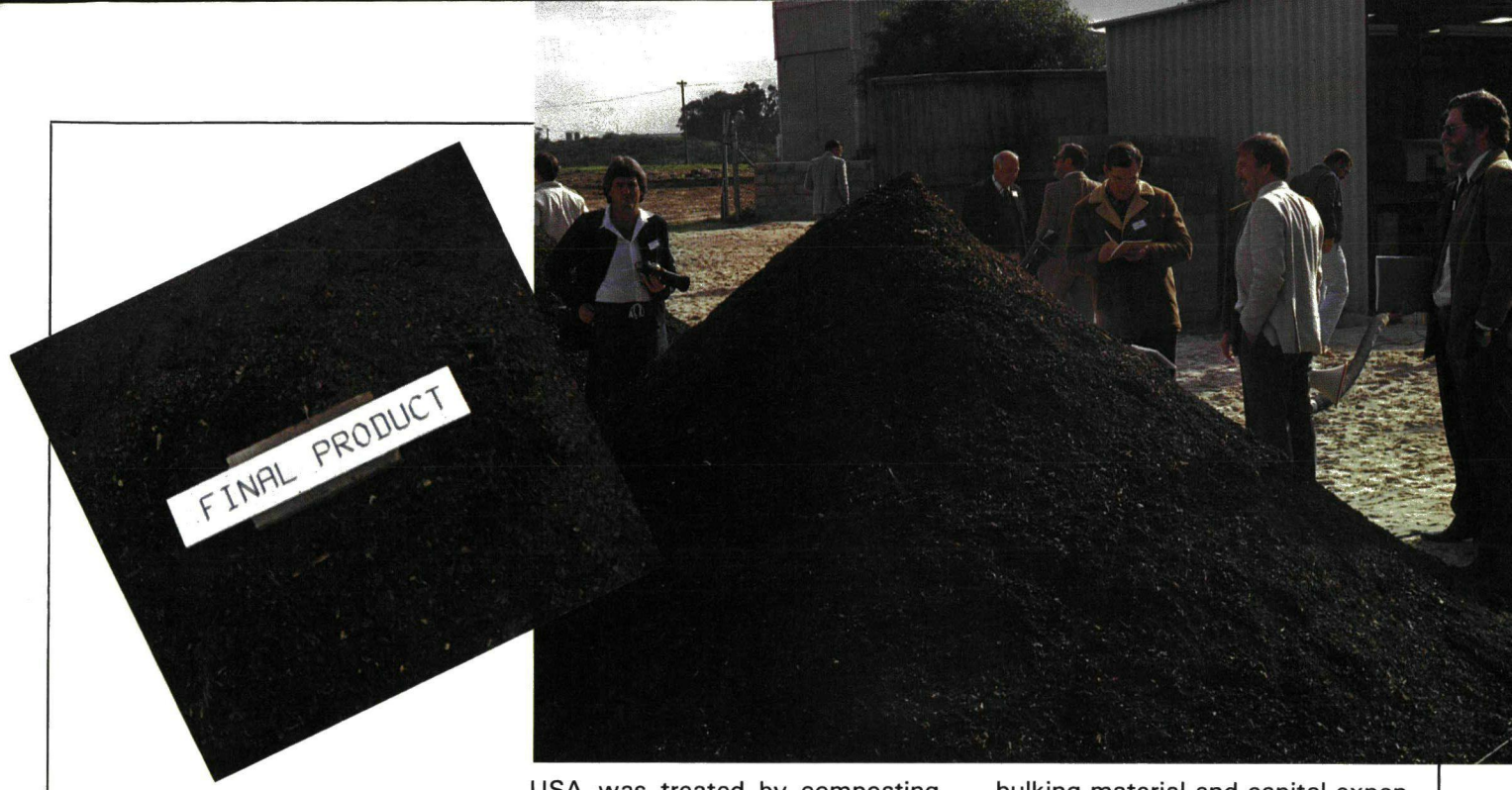


Dr E Joubert, onderburgemeester van Windhoek, en sy vrou, dr Mark Chutter, pasuitgetrede president van die LSSA, Shirley Bethune, kongresorganiseerder in Windhoek en mnr en mev JHJ Jordaan, sekretaris van die Departement van Waterwese, SWA/Namibië.

It all began as a research project in 1972 at the Biological Water Management Laboratory at the US Department of Agriculture in Beltsville, Maryland. The result was a successful forced aeration composting process. In 1982 the National Institute for Water Research of the CSIR, under contract to the Water Research Commission, commenced a research project on the feasibility of the process under South Afrikcan conditions at the Bellville sewage works. Mr Bill Ross, Branch Manager of the NIWR in Bellville, says that from the operational criteria generated on the prototype plant at Bellville forced aeration composting has proved to be suitable for South African conditions. In the following article NIWR and WRC personnel deal with the advantages, costs and use of forced aeration composting.

From Beltsville to Bellville: How to make use of the wooma in your sludge

A question which immediately comes to mind when discussing sludge stabilisation by means of forced aeration composting, is what makes this method so unique when compared to other composting and stabilisation methods? According to Mr John McGlashan, Senior Adviser at the WRC, forced aeration composting differs from other methods in that it has the ability to produce a sludge which is both stabilised and disinfected. The most widely used sludge stabilisation method in use



in South Africa at present, mesophilic anaerobic digestion, although it produces a stabilised sludge does not disinfect the sludge.

The process is effective and also simple to operate which means that it can be applied at both small and large sewage works. These advantages, therefore, make it especially suitable for South Africa with its fruit salad of first and third world situations.

According to Mr Hannes Nell, Chief Coordinator, Solid Waste Projects at the NIWR Bellville, other advantages include:

- ☐ production of a hygienically safe end-product;
- ☐ production of a stabilised soil conditioner with relatively high nitrogen content (1,5 to 3,0 per cent);
- ☐ self-generating high temperatures results in low electrical energy requirements;
- ☐ relative insensitivity of microbiological process to changes in environmental conditions allows for wide differences in input materials;
- ☐ low-level technology requires only unskilled labour; and
- ☐ ecologically acceptable disposal method.

Looking at the situation in America, leaders in the field of forced aeration composting, Mr Nell points out that over the last 10 years the number of sludge composting plants in America has rapidly increased. Compared to 1975 when less than 1 per cent of the sewage sludge production in the USA was treated by composting, more than 250 sludge composting plants have been constructed since the completion of the research project at Beltsville.

Mr Nell attributes this soaring figures to the fact that the increased number of waste water treatment facilities are producing more and more sewage sludge. It is estimated that approximately 23 000 tons of dry sewage sludge is produced daily in the USA at present representing a 66 per cent increase over the 10 years since 1976.

"New legislation has also eliminated or severely restricted certain disposal options such as sea disposal, lagooning and landfilling," Mr Nell says. "A recent ruling by a US Court in favour of ocean dumping by the City of New York has temporarily delayed the phasing out of sea disposal, but the expectation of ocean dumping being terminated in the near future, has contributed greatly towards the development and acceptance of composting as a method of sludge treatment."

COSTS

Landfilling and ocean dumping can be cheaper than forced aeration composting under certain conditions, but additional benefits such as its fertilizer value and soil conditioning characteristics make forced aeration composting a cost-competitive method.

"American experience indicates that about 40 per cent of the total costs of composting can be attributed to labour and approximately 20 percent each to maintenance, bulking material and capital expenditure," Mr Nell says.

"It must be remembered, however, that the cost structure of composting will vary between local authorities," he continues. "A detailed assessment of the economic desirability of composting should be made before a municipality embarks on such a venture".

AGRICULTURAL VALUE

Forced aeration composting of sewage sludge is a suitable treatment method and offers a solution where a high ground water table restricts the dumping of sludge, where odour and fly breeding presents a problem in urban areas and where land for dumping or disposal of sludge is expensive or unavailable.

According to Mr André Kitshoff, scientist at the NIWR, sludge treated by means of forced aeration composting could quite safely be applied in agriculture if the compost complies with the health requirements. Applying sludge in accordance with guidelines developed by the NIWR eliminates the danger of transferring disease and toxicity of heavy metals.

"The application of these guidelines restricts the problems involved in the agricultural use of compost to a minimum," Mr Kitshoff says.

The use of composted sludge in agriculture has the advantages of saving on fertilizers and pesticides, results in higher quality plants being cultivated, greater harvests and less water required for irrigation.

Computers aid eutrophication control

A newly unveiled decision support system (DSS) can assist water quality managers in assessing the impact of eutrophication control measures on the trophic response of South African reservoirs.

Developed with Water Research Commission funds by Dr DC Grobler of the National Institute for Water Research, CSIR, and Mr JN Rossouw of the Hydrological Research Institute of the Department of Water Affairs, the DSS is an interactive computer based system that can help decision makers utilize hydrological and water quality data and mathematical models to solve eutrophication problems. It can also assist managers in the interpretation of modelling results and provides a tool for the selection of optimal management alternatives for eutrophication control.

According to Dr Grobler South African water authorities have opted for treating the *causes* of eutrophication and decided to base their decisions on whether to impose eutrophication control in a catchment or not, on the trophic response of receiving water bodies.

To do that they needed a management orientated eutrophication model and in order to meet this need a dynamic Reservoir Eutrophication Model (REM) was developed for South Africa with its highly variable hydrological conditions.

However, the REM model consisted of well developed submodels such as a phosphate export model, a dynamic phosphate budget model, etc. which were unfortunately not integrated. The submodels were all running on different main frame computers and only used by the people who developed them.

As far as the users, the water quality managers, were concerned, they did not have the specialized knowledge to link all these submodels together.

The solution to this problem was to create a mediator between the sub-models and the decision makers who have to make specific decisions, whether a certain permit application has to be granted or not and so all the submodels of the REM model were incorporated into a decision support system (DSS).

Dr Grobler says the first version of the DSS is already being used by the Department of Water Affairs.

As the developers of the DSS receive feedback from the users, the first version of the DSS will be modified and adapted into second and third versions.

PROTOTYPE

The prototype version was loaded with hydrological data, in the case of the Vaal Dam, received from the Directorate of Planning of the Department of Water Affairs, used for simulating water requirements in the Vaal catchment.

The DSS also has a point source module with a menu for drafting all sorts of different options in terms of point source control, incorporating things like the point source discharge, the annual growth rate, etc. This generates point source loads, which together with the non point source loads and water quantities generated with the hydrological model is then routed into a phosphorous budget model for the reservoir from which a time series of phos-

phorous concentrations in the reservoir can be simulated.

The results can be displayed in a number of different ways: on a screen or on a printer, and plotted in the form of boxplots, probability plots and time series plots.

SCENARIOS

Dr Grobler says typical scenarios which can be run are the response in time, e.g. for the years 1990, 1995, 2000, 2005 up to 2020, of a specific impoundment to changing phosphate loads.

By selecting a particular date the system will automatically select the right hydrological data and build the growth rates for effluent volumes, etc.

Another option offered by the DSS is the impact of different effluent phosphate concentrations. It can either be assumed that all point sources comply to a uniform standard, for a specified standard. (One is not limited to 1 mg/ℓ), or you can test what will happen if you make it 5 mg/ℓ or 0,1 mg/ℓ. An individual standard for each point source can be selected, if for some reason this is required. In addition an option where no control is applied can also be studied.

With regard to phosphate losses in rivers one can again choose from different options. You can specify, for example, the same percentage loss of phosphate for all point sources or a different percentage loss for each point source.

Once a scenario has been generated the program automatically runs the required models for simulating the phosphate concentration in the reservoir and thereafter presents the expected results in various graphic displays.

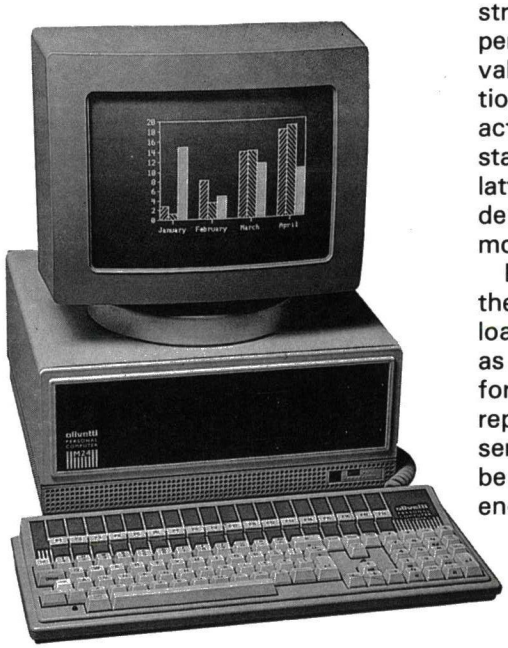
Dr Grobler stressed that the development of a DSS is a team effort between users and DSS developers.

''Users must use the most recent version of such a decision support system in practical applications, and in using it they will find shortcomings or enhancements that they require and then feed that back to the developers who keep on developing new versions of the system to meet the users' requirements. If cooperation and interaction is not present then any DSS that is developed will be a failure''.

Another data base supported by the Water Research Commission

Earlier this year, the need for a hydrological data base in addition to the eight hydrological data bases at present being developed by the Department of Water Affairs (see *S.A. Waterbulletin vol. 12:1* February, 1986) was identified by Mr S van Biljon, Deputy Director of the Directorate of Hydrology of the Department of Water Affairs. Programming of this additional data base was also supported by the Water Research Commission as part of its contribution towards the development of the National Hydrological Information System within the Department.

An important activity of the hydrologist is the filling in of gaps in streamflow records where, for one reason or another, the actual data are missing. A common reason for missing data is the temporary breakdown of the mechanical data recording device. Floods in South Africa's rivers also tend to wash away recorders, leaving considerable gaps in records. Another hydrological activity involves the extension of records backwards in time to make a longer continuous record. (Long records are of particular use for long-term planning sudies.) Various interpolation, regression and mathematical modelling techniques are available in the hydrologist's repertoire for both filling gaps and extending records which result in a replica of the historical record of monthly flows at a given measuring station. The data base described here was developed in order to catalogue and permanently store these records which have, until now, been scattered in various publications and unpublished reports; some more readily available than others.



There are three hierarchical levels of information stored in the data base. On the highest level, the data have been structured to contain basic information about the measurement site, including place and river names, drainage region code, latitude and longitude. This is followed by a second level containing information about the report or publication in which the synthetic record was first described, including author, title of report, date published, method of gap filling or extension, discharge table used, catchment area size and the mean annual precipitation of the site. This information is at a different (lower) level from the site data because there may be more than one report or publication (and therefore more than one historic replica of flow record) for a given measuring station. The various reports for a given site are all linked to a single site record. At the lowest hierarchical level, individual monthly streamflow values for the entire period of the record are stored. Each value is accompanied by an indication of its source, this being either actual (if directly from the recording station) or derived. In the case of the latter, an indication of the method of derivation is also given with each monthly value.

Provision has been made for both the on-line (interactive) and batch loading of data. Various summaries as well as the actual data (in the form of computer printouts, screen reports, line-printer graphical representations or on magnetic tape) may be extracted by means of a suite of enquiry programs.

Best places phosphate standard in perspective

Mr Hendrik Best.

Mr Hendrik Best, Managing Engineer of the Water Quality Division of the Department of Water Affairs, criticised statements by members of research institutions and other scientists on the expected impact the 1 mg/ℓ phosphate standard will have on the water environment.

Speaking at a demonstration of the new decision support system for eutrophication control held at the National Institute for Water Research, Mr Best said that the same researchers and scientists who had played a leading role in the formulation of the phosphate standard, are now unwittingly or knowingly abetting resistance against the standard by casting doubt on its efficacy.

He said these statements are being misinterpreted by the general public and are being used to either motivate objections to the standard or as excuses for failure to comply.

The following is an extract from Mr Best's speech, in which he places the effluent phosphate standard in perspective.

Almost nine years of investigations and research by leading water research institutions and limnologists in the country culminated in the promulgation of the special phosphate standard for effluents by the Minister of Water Affairs as a first step in a long term strategy to combat eutrophication of water bodies.

In implementing the standard, the Department of Water Affairs is faced with certain problems of which two can be highlighted here:

- ☐ Firstly, because the standard has economic implications, extreme antagonism is being experienced from the effluent producers affected.
- ☐ Secondly, as is the case with all effluent standards, the Water Act provides for exemption to be granted for exceedance or non-compliance in cases where such exemption can be shown to have little or no detrimental impact on the water environment.

The decision support systems in the past available to the Department, to assess the impact of exemptions are not only tedious and time consuming to apply, but also require expertise which is not normally part of the training and background of a Water Pollution Control Officer. As these support systems assume impoundments to be in a steady state and also ignores the fate of phosphates in transit in natural streams, the results are in doubt. Feedback to support or disprove the results of these assessments is not available in the short term and might even be masked by the trophic response of impoundments to other sources of phosphate.

PROBLEMS

Statements by members of research institutions and scientists on the expected impact of the phosphate standard on the water environment are being misinterpreted by the general public and are being used to either motivate objections to the standard or as excuses for failure to comply.

Some typical statements which feature in the media, scientific reports and magazines are the following:

"The 1 mg/ℓ phosphate standard will not alter the hypertrophic status of certain impoundments."

This statement however fails to elucidate the following facts:

- ☐ Conclusions reached are based on the results of a variety of models in use for the prediction of impoundment response to nutrient inputs and which yield highly variable results. Just about the only common denominator in these results is that the present phosphate standard will in fact reduce the percentage of time that nuisance levels of

chlorophyll concentrations will be exceeded and will after all serve a useful purpose as a first step in a long term strategy for effective phosphate management.

- ☐ Most of the models in use assume static conditions and tend to overestimate the extent of phosphate exchange between sediments and the water body in an impoundment.
- ☐ In the dynamic real life situation which is characterized by highly variable hydrological conditions, predicted responses will always tend to be on the pessimistic side.

"In the Netherlands the removal of phosphate from sewage effluents has proved to be a failure because receiving lakes are still green. Diffuse sources such as the use of inorganic fertilizers and animal wastes on farm lands are the major contributors of phosphates to the water environment."

These statements, however, fail to explain inter alia the following to the uninformed reader:

- ☐ If point sources of phosphates have not been controlled, lakes in the Netherlands might have been equally as green but chlorophyll levels might have been elevated.
- ☐ In the Netherlands, ground- and surface water form hydrological units to a much greater extent than in South Africa. In addition ground water levels are shallow — less than 0,5 m in the West and North and 1 – 3 m in the East. Groundwater in the Netherlands is therefore susceptible to pollution which in turn results in pollution of surface sources.
- ☐ The stock density per unit ground area in the Netherlands is much higher than in South Africa. The mass of manure and animal wastes that has to disposed of per unit of ground area is accordingly much higher.
- ☐ Soil pH's are generally lower than in South Africa and soils are subject to greater bacterial activity with the result that phosphates in inorganic fertilizers and animal wastes are more likely to be mobilised in a biologically available form.

It stands to reason therefore that diffuse sources of phosphate are likely to have a considerable greater impact on the trophic status of lakes in the Netherlands.

The Department of Water Affairs has always considered the phosphate standard as the first step in a phosphate management strategy which may require supplementary action in future to achieve the required results. The cost effectiveness of any suppplementary action will be duly considered before such action is decided upon.

In the meantime, some of the problems related to making decisions on the implementation of the phosphate standard could be readily resolved if:

- ☐ the scientific community takes care not to create the impression that they are resisting the Department of Water Affairs' effort in this regard.
- ☐ the scientific community would continue in their supporting role of the past.

In the light of the development of the new decision support system for eutrophication, I am confident that the Department can in fact depend on this valuable support.

Indaba my Children

Drought Relief water activities in Bophuthatswana during 1984, 1985, and 1986.

Africa was the romantic setting for the multimillion dollar Hollywood hit, *Out of Africa,* portraying an idyllic Africa of bygone days. Closer to the truth, however, Africa is a continent plagued by every natural disaster possible. Drought being prominent amongst these.

''Man himself has created the conditions in which less than average rainfall can result in disastrous famine,'' Mr Collin Campion said at a seminar on technology transfer in water supply and sanitation held at Mmabatho in Bophuthatswana recently. Mr Campion is the Coordinator — Administration of the organisation Drought Relief in Bophuthatswana.

Mr Campion continued by saying that a drought will only become a disaster if the land has been mismanaged before, during and after the drought.

Apart from feeding people and stock, and creating new jobs, Drought Relief has done a great deal in relieving the water needs of the rural communities of Bophuthatswana during the worst drought within living memory through a concerted effort to exploit and develop groundwater resources.

The majority of villages in Bophuthatswana (as in the rest of Southern Africa) rely on boreholes for their water supplies.

Borehole equipment can be anything from a handpump or windmill to an engine driven pump. A reservoir may or may not be present. Usually both people and livestock have to drink from these watering places.

According to Mr Campion there are over 4 000 boreholes in Bophuthatswana. For their maintenance the Departments of Public Works and Water Affairs have established eight Regional Offices and store depots at which are stationed anything up to six mobile maintenance teams.

FAILURES

"Early in 1984 reports of borehole failures began to stream in to the Drought Relief office," Mr Campion said. "At first it was assumed that the boreholes had dried-up due to the drought. It soon became clear that this was not the case. Water tables may have dropped, but mechanical failure was invariably the problem."

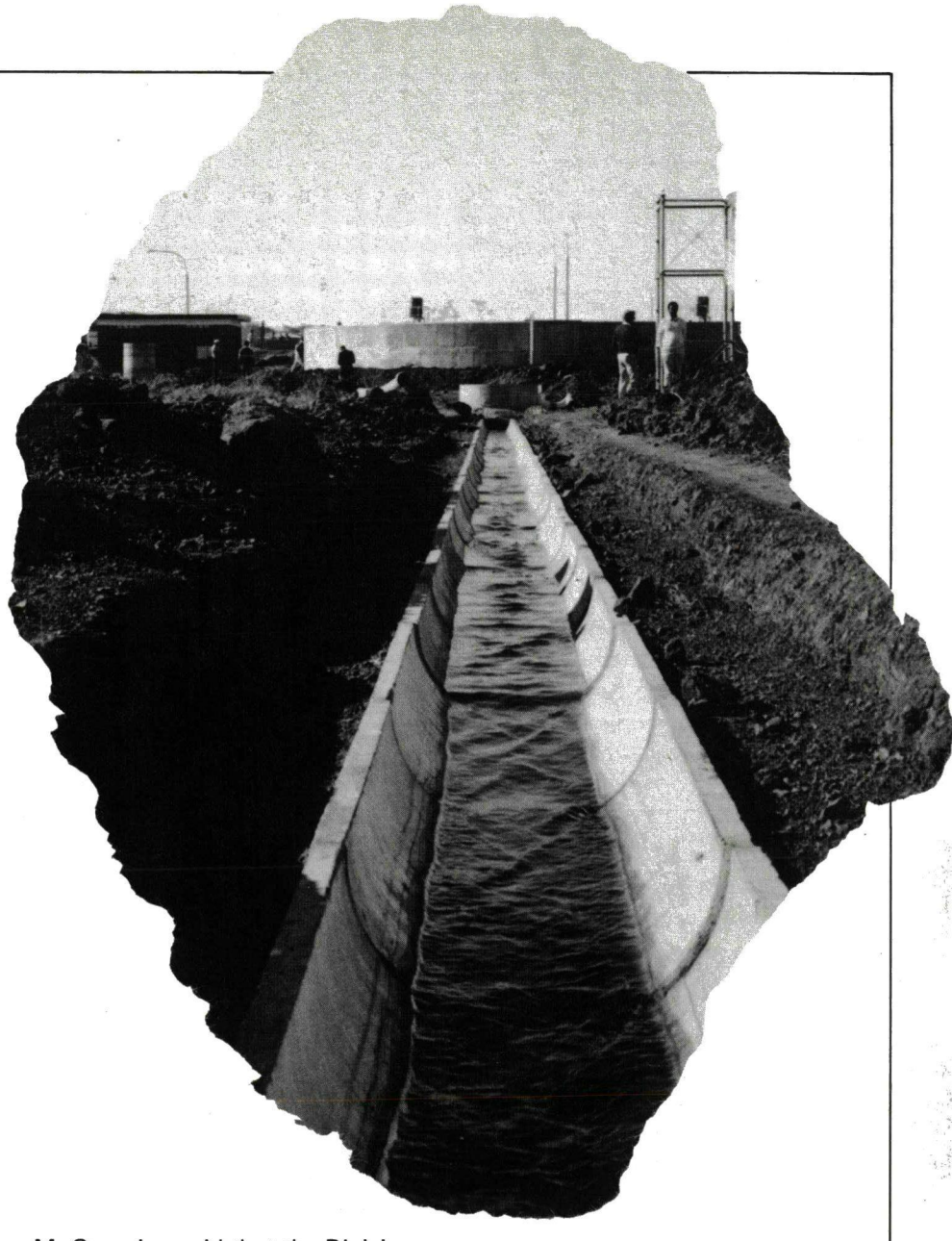
In the small community of Bona-Bona, for example, it was found that out of 43 boreholes only three were still in operation.

Drought Relief and the Bophuthatswana Defence Force acted together by mobilising emergency maintenance teams which are still in the field.

During the 1985/86 financial year, Drought Relief, using commercial contractors, sank 81 new boreholes. Of these only 31 were eventually equipped. The failure rate was high.

During the same period, the Department of Public Works and Water Affairs, also made use of commercial contractors and sank 213 new boreholes of which 105 were successful. Using its own rigs the Department sank a further 21 successful boreholes. Mr Campion warned, however, that five times this number is needed to make up the backlog.

Because it is the rural population who suffers most during times of drought, Drought Relief plans to direct their future efforts towards an improvement of the quality of rural life.



Mr Campion said that the Division of Water Affairs is currently responsible for the whole spectrum of water supply throughout Bophuthatswana. This includes the bulk supplies to cities and other urban areas; supplies to hospitals, schools, police stations, clinics, rural villages, state owned farms; primary supplies to agriculture; the operation of water treatment plants; the maintenance and repair of over 4 000 registered and equipped boreholes, as well as the motivation, planning and implementation of future programmes.

According to Mr Campion the Division of Water Affairs is at present operating with approximately 25 percent of the required staff and unless the staff shortages are alleviated, no significant improvement in rural water supplies can be anticipated.

Stressing that water is any nation's most important resource, Mr Campion suggested that instead of the Division of Water Affairs being responsible for new borehole supplies and borehole maintenance throughout Bophuthatswana, this responsibility should rather be vested in Drought Relief. The Division of Water Affairs should instead concern itself with the long term planning and provision of bulk supplies.

In conclusion, Mr Campion said that the construction of farm dams is very important to the rural communities. Drought Relief has been responsible for the construction of 17 such dams. The Tribal Authorities cooperated in selecting the sites and the villagers hand-built the dams. These dams, now contain water and are being used.

Chutter urges limnologists: Prepare for environmental impact assessment in South Africa

I believe that it is timely for members of the limnological community to prepare the ground for the day that environmental impact assessment will be required by law in South Africa.

This was said by Dr Mark Chutter, President of the Limnological Society of Southern Africa (LSSA) when he delivered his presidential address at the opening of the LSSA's annual congress in Windhoek earlier this year.

Dr Chutter discussed the role of the limnologist in environmental impact assessment and offered some ideas about what he believed the limnological community should be doing about environmental impact assessment now.

He said that the essence of environmental impact assessment to him was a thorough analysis of the consequences — including economic, sociological and ecological — of a proposed action on the environment, like building a new dam, for instance.

"Feedback should take place from the experts who analyze the consequences of a proposed action to the planners of the action to moderate the consequences of the action if necessary. Finally a statement of the proposed action and its expected consequences must be made available to the decision takers who weigh the pros and cons and decide. In some countries the "decision takers" are technocrats but in others it is the public at large who may be called upon to vote on an environmental issue."

According to Dr Chutter environmental impact assessment requires a holistic approach in which limnology is only one aspect of the ecological component.

"Any limnologist who claims that he can do environmental impact assessment all on his own is either incredibly arrogant, incredibly ignorant or has a very different understanding of environmental impact assessment.

"What limnologists can and should most definitely be involved in is ecological impact analysis.

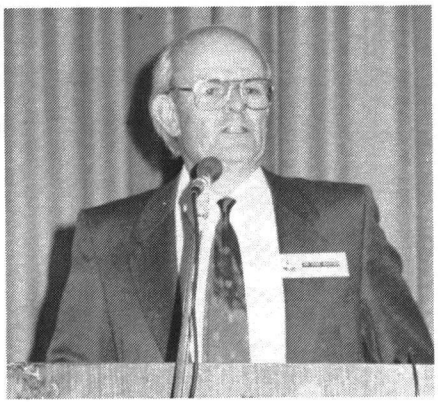
Dr Chutter said that in assessing environmental impact limnologists must remember the difference between preservation and conservation.

"From my experience too many of us fall into the preservation trap —

maintaining the ecological status quo at all costs — an impossible ideal unless we are also prepared to maintain present standards of living and population sizes at all costs. Nevertheless in the few environmental impact studies that I have read undue emphasis is placed on species lists in impact areas as a sop to ecological considerations.

"A species list implies an all or nothing situation — either the fauna/flora of the site is so remarkable that the site must not be changed or the biota is so ordinary that there will be no loss through destroying it.

"Limnologists have to approach



impact assessment through asking what will this development do to the chemical and physical environment and then how will this feed back into the biological processes.

"Assessment for conservation does allow for constructive feedback between ecological analyses and development plans which it may be possible to modify for conservation purposes."

In conclusion Dr Chutter expressed the following ideas about what limnologists could be doing to prepare the ground for the day that environmental impact assessment will be required by law in South Africa.

Limnologists should seize every opportunity that presents itself to record and analyse before and after development situations.

Limnologists should attempt to identify future developments and where they will take place and gear research programmes to them.

Limnologists should be developing predictive and quanitative ecology "because this is really what impact analysis is all about."

Limnologists should be aware of general ecological theory and be critical in their application of it to South Africa's semi-arid zone conditions.

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Getting an act together

A development plan for aquaculture in South Africa,
presented at Aquaculture '86 by RD Walmsley* and MN Bruton*

World output from aquaculture has increased rapidly in recent years, being estimated at approximately 6 million tonnes in 1975 and exceeding 10 million tonnes in 1984 (Science Council of Canada, 1984). Many countries (eg. Japan, Denmark, the United Kingdom and United States of America) are expanding their aquaculture industry from a solid industrial base with a well developed infrastructure. Their governments have all recognized aquaculture as a productive industry with great potential, and they have executed policies and programmes to support the growth of the industry. The potential of aquaculture in South Africa has been highlighted by Safriel and Bruton (*Aquaculture in South Africa, a cooperative research programme,* 1984). However it is apparent that there are many problems which need to be overcome before a healthy industry emerges. This article presents some of these problems and makes suggestions for a development plan for aquaculture in South Africa.

POTENTIAL BENEFITS OF AQUACULTURE

☐Opportunities for commercially viable business

Aquaculture ventures should be regarded as commercial enterprises which are self-sufficient and profitable. At present there are successful commercial concerns in South Africa involved with rainbow trout, Pacific oyster, waterblommetjies, ornamental fish and Nile crocodile. There are many more species, — eg. prawn, catfish, tilapia, abalone, marron, mussels and crab which show high potential and could lead to successful commercial aquaculture enterprises.

☐Employment opportunities

As with any commercially viable business, employment opportunities both for skilled and unskilled labour are created and therefore, particularly in South Africa where employment is a problem, the industry has worthwhile potential. The numbers of skilled and/or unskilled labour is dependent on the species cultured eg. oyster farming requires considerable manual manipulation (unskilled labour) of the product whereas finfish require less.

☐Continuous production and availability of products

Most products which are harvested from the wild have a distinct seasonal cycle in their production, thus are not continually available. These seasonal cycles can, to some extent, be moderated by making aquaculture produce available for marketing in other seasons eg. by regulating food supply or temperature.

☐Improved quality standards

The harvesting of wild material sometimes leads to a product which has uncertain quality. Aquaculture offers an opportunity to apply industrial quality control criteria in the products which are marketed.

☐Management and utilization of natural resources

The production of aquacultural biomass can alleviate the exploitive pressure placed on natural populations of the same species. In addition it can be used to stock natural environments with the species and thus renew the exploitable biomass. Aquaculture, by utilizing water, also makes use of a natural resource at the particular site or situation where it is carried out.

☐Competition in new export markets

Markets for aquacultural produce exists in Europe and North America, particularly for high quality products where there is a continuity of supply. South Africa has the capability of providing such markets with a variety aquaculture products, e.g. oysters, crocodile skins, ornamental fish etc.

☐Import substitution

Substantial quantities of cultivated seafoods are being imported into

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**JLB Smith Institute of Ichthyology, Private Bag 1015, Grahamstown, 6140.

South Africa. The imports include large quantities of processed mussels, oysters, shrimps, in addition to numerous ornamental fish. An opportunity exists to redress this trade imbalance by the development of South African aquaculture.

☐Restrictions currently facing the aquaculture industry

There are currently numerous problems facing the development of the South African aquaculture industry. These range from socio-economic and political through to technical and scientific that will need to be addressed and overcome if a successful industry is to emerge.

☐Lack of recognition that aquaculture is indeed a valuable potential resource

South Africa has a well developed marine fisheries industry, which on account of economics and aggressive marketing, has tended to dominate and cloud the potential of aquaculture. In addition, because of numerous past failures with many aquaculture ventures, the wrong image has been projected. It has been accepted in many parts of the world that aquaculture *per se* will not solve the expected protein crisis, and that aquaculture should address high quality food or product markets eg. trout, salmon, shrimp, ornamental fish and crocodiles.

At present the Government has shown little interest in aquaculture as an industry and not clearly defined how aquaculture fits into any particular Department. Although the Commission for Administration has announced that the Department of Environment will be responsible for matters pertaining to aquaculture, no statement has been made by that Department as to how it is going to address the aquaculture issue.

☐Jurisdictional responsibility

In South Africa, numerous institutions (State, Provincial and municipal) have a direct or indirect jurisdiction over aquaculture. The prospective aquaculturist is faced with a maze of jurisdictions over fisheries, inshore water, licensing and permit regulations, financial aid, health and marketing. These tend to have inhibitory implications for the planning and decision-making required to become involved in aquaculture.

☐Lack of government incentives

The research and development required to convert an organism from a candidate species to a commercial one is time-consuming and expensive. There are few current financial schemes to assists industry with such development.

☐Lack of a positive public policy statement

Countries that have a well developed aquaculture industry have developed clearly defined policies which accept aquaculture as an important contributor to the economy. The absence of any such statement on policy in South Africa discourages industry, science and government itself from developing the state of the art.

☐Lack of demonstration facilities

As in land-based farming, pilot testing and demonstration facilities are an essential step in the transition from laboratory research to commercial production. From an historical point of view, Nature Conservation Departments in South Africa have provided considerable input into providing facilities where numerous aquaculture species have been evaluated in demonstration units. However, in recent years this input has declined due to changes in policy within many of these Departments. There is at present no state-sponsored demonstration facility for aquaculture, marine or freshwater.

☐Inadequate marketing and product development

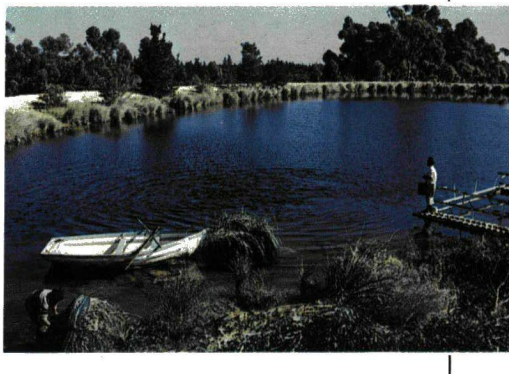
The per capita consumption of fish and other aquaculture products in South Africa is low by comparison with other countries. Minimal market and product development in our domestic market has resulted in a restricted consumer demand for aquatic food. Aquaculture can supply specialized products to satisfy consumer demands, but such markets must be clearly identified and developed.

☐Inadequate technical training development and business management expertise

Many previous aquaculture concerns were unsuccessful because of poor technical and/or business management. A lack of hands-on training in the culture of specific organisms is perhaps a major technical limitation to aquaculture development. It is interesting to note that the University of South Africa offers a two day business course in fish farm management whilst Rhodes University has the capability of offering technical courses through its Department of Icthyology and Fisheries Science.

☐Inadequate extension service

If aquaculture can be regarded as a form of agriculture then it is important that, like agriculture, it has a system in which an advisory and/or veterinary service is available for aquaculturists. Although provincial



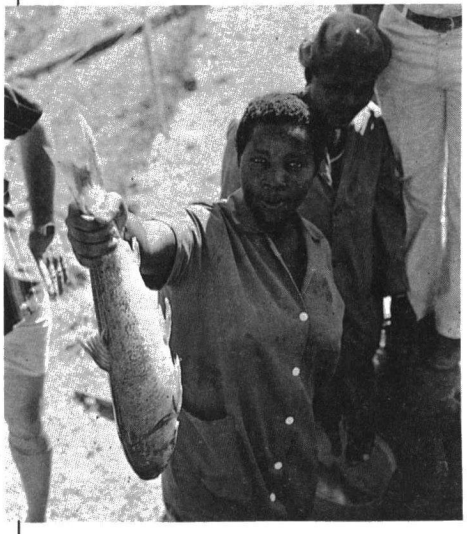
Nature Conservation Departments previously provided a form of service (eg. for trout), their contribution to this has decreased in recent years. The current contribution by the Fish Disease Unit at Onderstepoort in providing an analytical service for fish disease is extremely valuable. However, this would have to be expanded in order to cater for a developing industry which covers a wide range of aquaculture organisms.

☐**Inadequate data and statistics**

The orderly development of an industry is impossible unless rigorous statistics on the performance of that industry are available to those involved in planning. At present production data and economic information on aquacultural projects are lacking and there appears to be a reluctance on the part of numerous parties to make such data available.

☐**Lack of application of existing knowledge**

There is a great wealth of scientific knowledge on most aquaculture species within South African Universities, State and Provincial Institutes. In addition, much knowledge has been developed overseas (e.g. North America, Europe and the Far East). Local aquaculturists tend to almost reinvent the wheel in their approaches to culturing organisms. It is logical that one should make use of existing knowledge before embarking on costly and time-consuming research and development projects.



☐**Inadequate enabling legislation**

The presence of legislation which supports a particular industry sends signals to the private sector that government is positive about that industry. Certain countries (eg. Nova Scotia) have aquaculture acts which encourage and regulate aquaculture. South Africa does not have any aquaculture act to clarify the many overlapping jurisdictions which currently exist.

AQUACULTURE: A DEVELOPMENT PLAN FOR SOUTH AFRICA

A fundamental premise of economic theory is that economic agents act in a manner which maximises their own welfare. Thus, if aquaculture is to be profitable, presumably it would be taken up by the private sector without any government intervention. Conversely, if it is not profitable, it is not worth pursuing and should be discouraged unless there are benefits for the society as a whole. However, discrepencies between profits and benefits may arise from a failure of the market to register the true society value, either because of the good itself or an imperfection of the market.

In considering why aquaculture has experience slow growth and numerous failures, two points should be considered:

☐**The infant nature of the industry**

This introduces considerable risk and uncertainty as concerns about environmental suitability, disease, technological innovations etc. all lead to a great deal of difficulty, components which are essential for development of the industry. Government support may be required to get the industry beyond this infant stage.

☐**Lack of infrastructure**

This requires an individual farmer to break new ground at each stop of the way, whether it is obtaining permits, setting up marketing and distribution systems or research and development. All these result in an inordinate load for the grower and, without assistance, often result in failure of the enterprise. Government support to provide infrastructure for the industry is therefore a prerequisite to its success. In reality the whole issue boils down to economics and it is imperative that each aquaculture species receives attention via the development of microeconomic models for that species. The only truly valid model is a fully funded, fully supported pilot project where actual costing of work components and marketing studies should be undertaken. This means a well planned operation involving industry, but supported by government biologists, economists and accountants.

In the two years since the last aquaculture symposium very little has been achieved in creating an infrastructure which supports the aquaculture industry. Some of the solutions and steps to be taken are obvious, in view of the abovementioned problems:

☐**Establishment of a lead agency**

As the aquaculture industry developes, the responsibility and direction provided by the national lead agency will become more important. Although the Department of Environment through its interest in Sea Fisheries has indicated that it has an interest in *mariculture,* no Department has accepted the portfolio for freshwater aquaculture. It suggested that the Department of Agriculture could be a suitable home for freshwater aquaculture. The responsibility of the lead agency might be to:

- develop a National Aquaculture Act and implement its policies
- review all regulations pertinent to aquaculture and resolve problems of conflicting jurisdiction
- consolidate and extend financial assistance programmes to the aquaculture industry through grants, loans and tax incentive arrangements
- sponsor thoroughly monitored pilot-scale projects in commercial aquaculture. Establish demonstration aquaculture operations at suitable sites in conjunction with industrial concerns.
- initiate market research to ensure that the South African aquaculture industry caters for both domestic and foreign markets
- provide a database for the industry
- sponsor and initiate development-oriented research that is reponsive to the needs of industry
- promote courses on aquaculture for the commercial species in South Africa

- coordinate the development of an extension service including veterinary services, disease diagnosis, management and technical advice, environmental monitoring
- promote technology transfer

☐Establish a coordinating committee for aquaculture

The functions of this committee might be suggested as follows:

- to provide a forum of interaction between industrial representatives and the government
- advise on policy and programme changes
- ensure coordinated action between government, municipal and provincial authorities
- identify the sources of financial aid
- assist with the implementation of the state or provincial aquaculture programme.

The secretariat for such a committee could be housed within the CSIR or within the government lead agency(ies).

☐Formation of producer associations

Although the lead agency and the secretariat can develop the aquaculture industry substantially it is important that a national consensus on aquaculture development be attained. It would be helpful if producers could form their own associations for the species under culture and then elect representatives for a national council of producer associations. Although there are already associations for trout and crocodile it is apparent that associations themselves require a better measure of coordination.

Waterpersele vir visboere bepleit

Tydens samesprekings met lede van die Presidentsraad in Junie vanjaar, het dr John Krause, vroeër 'n dosent aan die Universiteit van die Oranje Vrystaat en nou voltydse boer, 'n referaat gelewer oor die uitbou van visproduksie as werksgeleentheid onder die omstandighede van beperkte binnelandse water.

In sy referaat het dr Krause gesê dat van die nagenoeg 54 miljard m^3 wat die Suid-Afrikaanse spruite en riviere jaarliks as afloopwater bereik gaan nagenoeg 10 miljard aan vloedwaters en 12 miljard aan verdamping verlore. Weens omstandighede is die Staat verplig om reuse waterprojekte aan te gaan om soveel moontlik van hierdie afloopwater op te berg om aan toenemende behoeftes te kan voorsien.

Suid-Afrika se klimaat het ook tot gevolg dat verdamping die enkele grootste medeverbruiker van opgebergte damwater is. "Tydens opberging lewer hierdie water geen inkomste nie, skep geen noemenswaardige aantal werksgeleenthede nie, maar vorm tog, potensieel, die produktiefste omgewing vir voedselproduksie wat in 'n droë land kunsmatig geskep kan word," het dr Krause gesê.

"Die gebruik van water in Suid-Afrika is hoofsaaklik eenmalig, derhalwe is denkwyses en gevolglik die beplanning van maatskaplike en ekonomiese vooruitgang, hoofsaaklik gerig op volumetriese syfers van die oplewing van riviere en Staatsdamme vir 'n eenmalige gebruikswyse. Suid-Afrika het nog nie 'n ander benadering tot water geleer nie".

Dr Krause het gesê dat hoewel daar nie veel aan verdamping gedoen kan word nie, die verliese daaraan tot 'n mindere of meerdere mate met 'n ander benadering weerlê kan word. Die jaarlikse verdampingsverliese van ongeveer 12 000 miljoen m^3 van slegs die Verwoerd-Vaal- en Bloemhofdam is ongeveer die jaarlikse konsumptiewe gebruik van 25 stede die grootte van Bloemfontein.

Ten opsigte hiervan het die Oranje Vrystaat reeds die voortou geneem. Die Afdeling Natuurbewaring het sekere damme vir die kommersiële ontginning van varswatervis oopgestel en hierdie vis word reeds uitgevoer. Dr Krause voel egter dat hierdie eerste stappe nog ver is van die verwesenliking van die werklike potensiaal en dat die konsep nog verder ontwikkel moet word veral met die oog op die kleinboer.

"Daar is geen onoorbrugbare redes waarom van Suid-Afrika se grootste damoppervlaktes nie uitgemeet kan word vir die oopstel van waterpersele waar produsente vis en ander waterorganismes in hokkultuur kan produseer nie. Dit is reeds 'n ontwikkelde en gevestigde praktyk op byvoorbeeld die fjords van Noorweë, die mere van Skotland, die Baai van Tokio en die Laguna Baai van die Filippyne. Hierdie benadering tot Suid-Afrika se groot Staatsdamme is kerngesond want dit skep werksgeleenthede en bewerkstellig produksie van produkte wat reeds ingevoer moet word, sonder om 'n bykomstige konsumptiewe gebruik van water te vestig, het dr Krause gesê.

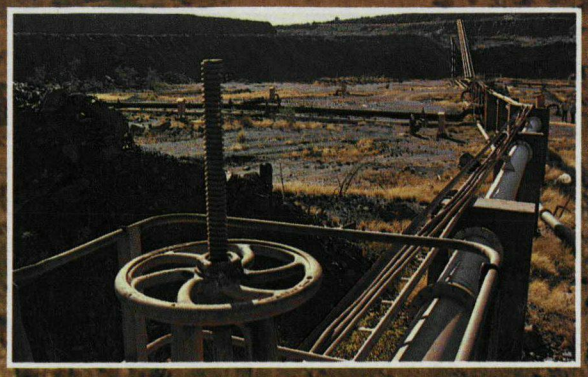
Hy het verder ook voorgestel dat ontwikkeling van 'n varswatervisbedryf rondom en op Suid-Afrika se grootste damme binne die denkwyses van die landbou moet plaasvind.

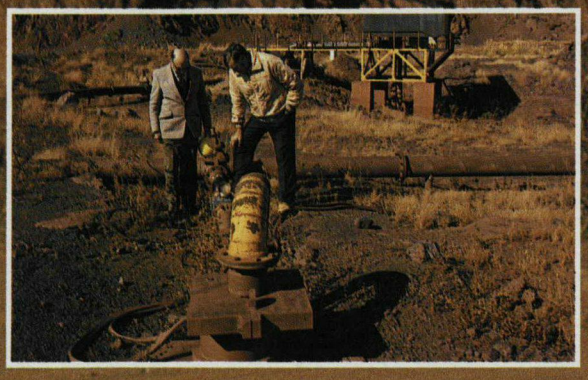
"Die oopstel van waterpersele beteken, gevolglik, ook die beskikbaarstelling van saad van vissoorte wat klein produsente kan aankoop, grootmaak in hokke, bewerk en bemark binne die raamwerk van 'n koöperatiewe opset.

VOORUITGANG

Om en op die dam, berus ekonomiese en maatskaplike vooruitgang nie soseer op reënval of leibeurt nie, maar op die daadwerklike inspanning van tegnologie deur middel van voorligting," het dr Krause gesê.

Dr Krause het afgesluit en gesê op wetenskaplike vlak is Suid-Afrika reeds daartoe in staat om die tegnologie van varswatervisproduksie te kan ondersteun. "Ons tekortkoming," het dr Krause gesê lê nou egter in 'n ware begrip vir die meermalige en nie-konsumptiewe benadering tot water en ekonomiese vooruitgang wat binne die begrensing van beperkte binnelandse water met hierdie benadering bewerkstellig kan word."





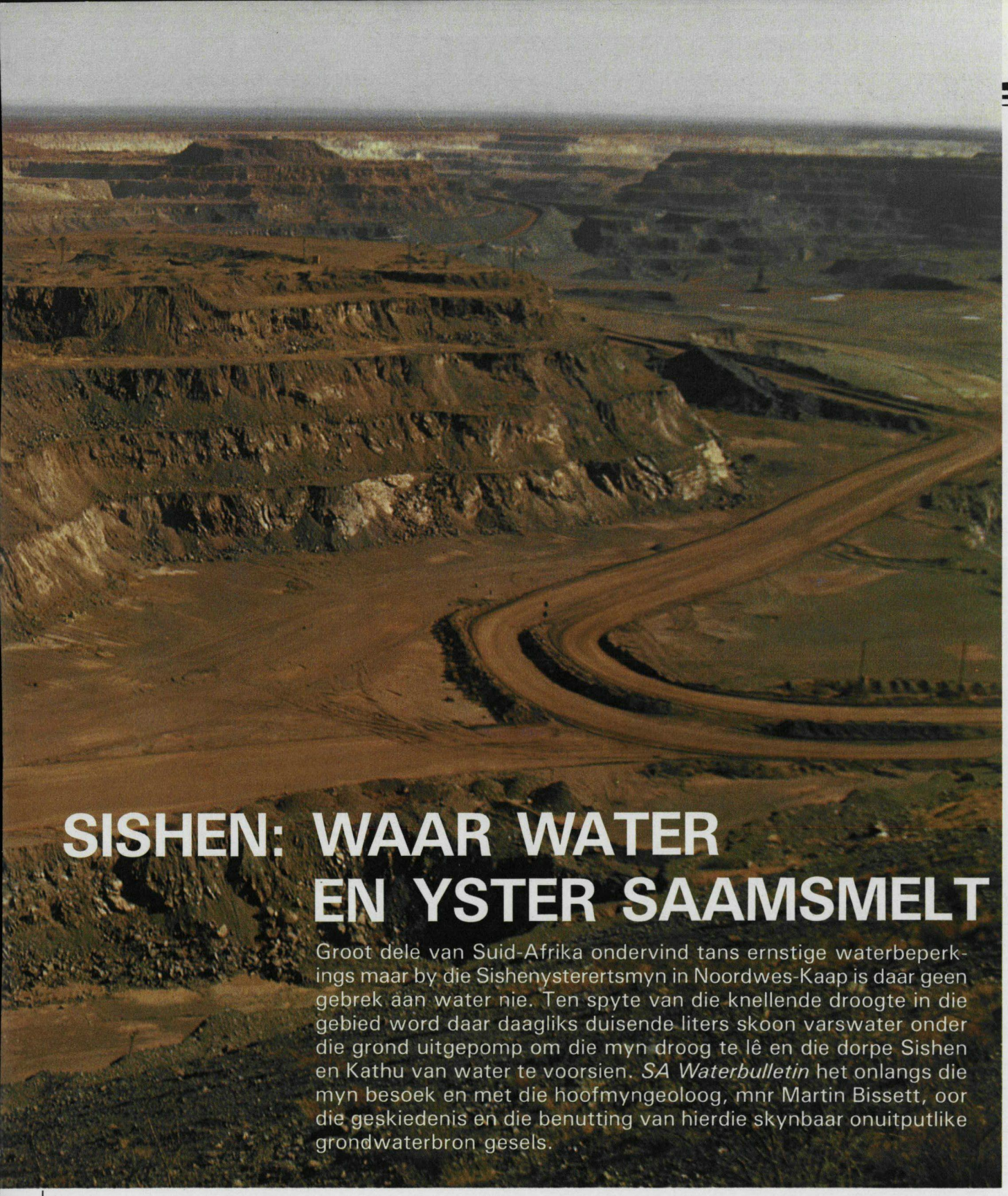
Yskor het in 1953 met ysterertsproduksie op die plaas Sishen tussen Kuruman en Postmasburg begin.

Destyds is aanvaar dat daar min ondergrondse water op die plaas was waarop die hoofysterertsliggaam lê, en die erts is aanvanklik droog vergruis en gesif. Watervoorsiening uit boorgate aan die myn en Sishendorp was toe 'n groot probleem.

Na deeglike prospekteerwerk in die Sishengebied is grondwater op drie plekke gevind: op die plaas Gamagara net wes van Sishen, in die Gamagararivierpoort, suid van die dorp en by Kathupan. Gedurende die vyftigerjare is uit hierdie boorgate tot altesaam 2 000 m^3/dag water onttrek om in die myn en in die dorp se waterbehoeftes te voorsien.

Die ontginning van die ystererts was aanvanklik tot vier heuwels van die Gamagararant beperk. Gedurende die sestigerjare is hierdie heuwels heeltemal weggemyn en het oop groewe in die plek daarvan ontstaan.

Die eerste aanduidings van grond-



SISHEN: WAAR WATER EN YSTER SAAMSMELT

Groot dele van Suid-Afrika ondervind tans ernstige waterbeperkings maar by die Sishenysterertsmyn in Noordwes-Kaap is daar geen gebrek aan water nie. Ten spyte van die knellende droogte in die gebied word daar daagliks duisende liters skoon varswater onder die grond uitgepomp om die myn droog te lê en die dorpe Sishen en Kathu van water te voorsien. *SA Waterbulletin* het onlangs die myn besoek en met die hoofmyngeoloog, mnr Martin Bissett, oor die geskiedenis en die benutting van hierdie skynbaar onuitputlike grondwaterbron gesels.

water in die myn self is in 1958 gevind en gedurende September 1967 is sterk grondwater in 'n ertsproduksieboorgat in die suidelike deel van die myngroef, die sogenaamde Heuwel 2-gebied, op 'n diepte van nagenoeg 30 meter oopgeboor. Hierdie water wat uitgepomp moes word sodat die erts gemyn kon word, het aanvanklik teen 'n tempo van 270 m^3/uur gevloei sonder dat die lewering enigsins afgeneem het of dat die grondwatervlakke noemenswaardig gedaal het.

Intussen het die waterbehoeftes vir die dorp Sishen herhaaldelik ter sprake gekom en in 1972 is die Afdeling Grondwater van die Department van Waterwese, by die probleem betrek.

Bo: Die Sishenysterertsmyn.

Bladsy 20: Mnr Jan Heynike, WNK, (links) en mnr Martin Bissett, hoofmyngeoloog van Yskor by een van die boorgate in die myngroef. (Middel) Die waterpypleiding vanuit die Heuwel 2-gebied. (Onder) Kathu se munisipale kantore. Mynwater het dié dorp in 'n lushof omskep.

Na 'n ondersoek het dit duidelik geword dat die pomptempo verhoog moes word om aan die waterbehoeftes van Sishen te voldoen asook om die groef as gevolg van die volgehoue verdieping effektief te ontwater.

Op 3 Julie 1973 is besluit om die heersende pomptempo van 270 m^3/uur na 540 m^3/uur te verhoog, maar ongeag hierdie verhoogde tempo, het die grondwatervlakke gedurende 1973/74 nog verder gestyg weens abnormale hoë reënval.

OORSTROOM

Die groot reën van die jare 1973 tot 1977, toe dit dikwels amper twee keer die gemiddelde jaarlikse reënval van 350 mm gereën het, het die watervlakke kwaai laat styg. Gedurende Mei 1976 het die grondwaterkompartement sy versadigingspunt punt bereik en het die ertsgroewe oorstroom. Dit het daartoe gelei dat baie van die toerusting vasgeval het en produksietempo's benadeel is. Plofgate was vol water en 'n duurder plofstof moes gebruik word. Die nat toestande in die groef het baie werkers gedemoraliseer. Instandhouding op die paaie is bemoeilik, met 'n gevolglike verkorting in die leeftyd van voertuigbande. Instandhouding van toerusting in die groef soos byvoorbeeld laaigrawe, is ook bemoeilik en addisionele koste moes aangegaan word om water vanaf die groefvloere te pomp.

Die Afdeling Grondwater van die Departement Waterwese het bereken dat die Sishengrondwaterkompartement gedurende die hoë reënvaljare, in 1974, ongeveer 140 miljoen m^3 water bevat het.

Intussen het die ertsproduksie, veral vir die uitvoer van ystererts via die 860 km spoorlyn na Saldanhabaai, geweldig toegeneem en is nog 'n myn, die Noordmyn, net noord van die bestaande groewe geopen.

Gedurende 1975 is besluit om die hele Sishenmyngebied met behulp van boorgate gedeeltelik te ontwater en net genoeg water te onttrek om droë groefvloere te verseker. Met dié doel voor oë, moes die ontwateringspomptempo egter drasties verhoog word sodat 'n doeltreffende daling in die grondwatervlakke bewerkstellig kon word.

Daar is ook vasgestel dat daar tussen die Noord- en die Suidmyn 'n gang loop wat die grondwaterkompartement in twee subkompartemente verdeel. Hierdie gang laat baie min water deur en daarom affekteer die uitpomp van grondwater in die Heuwel 2-gebied van die Suidmyn nie die noordelike deel nie.

In Desember 1975 is 'n aantal boorgate 30 meter diep met behulp van 'n 60 R-produksieboormasjien geboor en van dompelpompe voorsien wat die pomptempo tot 450 m^3/uur verhoog het. Gedurende 1976 is besef dat hierdie ontwateringsboorgate net 'n tydelike oplossing bied en is die dienste van 'n privaat boorkontrakteur verkry om addisionele gate te boor. Die kontrakteur het 'n netwerk van diep, groot deursnee pompgate geboor en sterk water van 30 en meer liter per sekonde per boorgat in die gebreksieerde lintyster en chert bokant die dolomiet getref. Die boorwerk het bewys dat die hoofakwifeer oorwegend in die basale breksiehoudende gedeelte van die Chertbreksie, die sogenaamde ''Mangaanmerker'' voorkom.

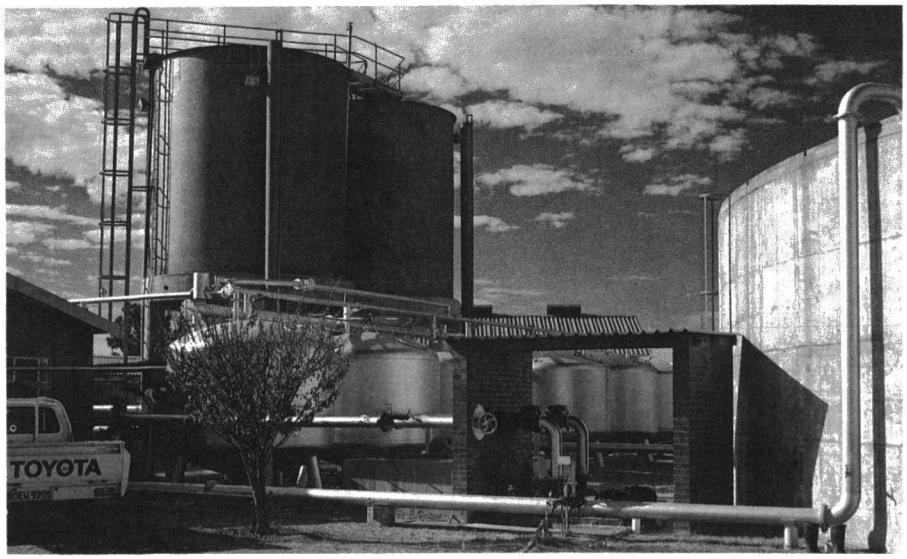
Die diepte van die mangaanmerker wissel oor kort afstande as gevolg van die kompleksiteit van die geologiese struktuur: op party plekke dagsoom hy, byvoorbeeld aan die oostekant van die myn op die plaas Bruce en raak al dieper hoe verder hy weswaarts gaan. Daar word verwag dat die grondwater sal hou solank as wat daar nie onderkant hierdie mangaanmerker gemyn word nie.

Teen die einde van 1977 het die pomptempo tot ongeveer 55 000 m^3/dag gestyg en tot die einde van 1981 naastenby dieselfde gebly. Intussen is ook met die ontwatering van die Noordmyn begin en nagenoeg 20 000 m^3 water is daagliks uit die ontwateringsboorgate gepomp.

Sedert April 1983 het Yskor in totaal ongeveer 26 miljoen m^3 water uit die kompartement onttrek om die myn se groewe droog te hou. Gedurende dié tydperk het die watervlak 'n bietjie gefluktueer, maar nie eintlik gedaal nie, en in die gebied suid van die gang het die

Chemiese ontleding van grondwater by Sishenmyn

Boorgat	Suidmyn	Noordmyn
pH	7,7	7,5
Elektr. Geleid. mS/m	56,6	59,4
TAL (as $CaCO_3$ mg/ℓ)	295	306
NH4 mg/ℓ	0,03	0,02
Ca mg/ℓ	66	73
Cl mg/ℓ	28	26
NO_3 (as N) mg/ℓ	1,66	1,88
Na mg/ℓ	17	16
Mg mg/ℓ	41	42
F mg/ℓ	0,2	0,3
Si mg/ℓ	13,9	17,2
K mg/ℓ	2,3	2,1
SO_4 mg/ℓ	28	23
P mg/ℓ	0,023	0,013
TOS (Tot. opgeloste stowwe mg/ℓ	563	581



Die waterversagtingsaanleg waar mynwater met kalk behandel word om dit vir huishoudelike gebruik geskik te maak. 'n Tweede watertoevoerstelsel met hardewater verskaf besproeiingswater aan privaattuine, parke en sportvelde in Sishen en Kathu.

watervlak selfs effens gestyg.

Daar is tans 16 ontwateringsboorgate op 'n rooster van 15 by 15 meter in die Heuwel 2-gebied van die Suidmyn maar net 12 van hulle word gepomp.

In die Noordmyngebied is ses ontwateringsboorgate waarvan vier gepomp word. Altesaam 11,45 miljoen m^3 water is gedurende die tydperk 1 Julie 1984 tot 30 Junie 1985 uit die kompartement onttrek. Met 'n gemiddeld van 416 m^3 water per uur uit die vier boorgate van die Noordmyn en 886, 9 m^3 water per uur uit die suidelike twaalf gate by Heuwel 2.

Gedurende 1986 is daar tot dusver as volg water uitgepomp: *Maartmaand* 1 163 m^3/uur suid en 337 m^3/uur noord; *April:* 1 060,8 m^3/uur suid en 336 m^3/uur noord; *Mei:* 1 060 m^3/uur suid en 355 m^3/uur noord.

Uit waterstudiegrafieke wat die myn byhou en waarop die reënval per maand, die watervlakwisseling bo seevlak en die maandelikse pomptempo met mekaar in verband gestel word, kan sedert Desember 1977 'n duidelike verskil van ongeveer 20 meter in die grondwatervlakke van die subkompartemente noord en suid van die gang waargeneem word. Die verskil het met die jare konstant gebly ten spyte van die groot verskil in pomptempo's in hierdie twee gebiede.

Die reënval het sedert Julie 1977 geen effek op die grondwatervlakke in die kompartement gehad nie aangesien die hoë pomptempo's veroorsaak het dat grondwatervlakke gedurende tydperke met hoë reënval, net stadiger gedaal het, maar geen styging getoon het nie.

Ontledings van die water in die twee subkompartemente het getoon dat die water vir die gebied noord van die Gang 'n gemiddelde ouderdom van ongeveer 4 000 jaar het, terwyl die water in die gebied suid van die Gang ongeveer 2 000 jaar oud is.

Ten einde die waterbeheerstelsel in die myn doeltreffend te laat funksioneer is dit noodsaaklik om presies te weet hoeveel water gepomp moet word. Om hierdie syfer akkuraat te bepaal, moet die pompinstallasie op 'n gereelde basis soos volg nagegaan word: Die uurmeter- en vloeimeterlesings tesame met die spesifieke tyd wanneer die lesings geneem is, word drie maal per week van elke individuele pomp versamel. Hieruit kan die werklike pomptempo en die pomptempo vir die tydsverloop tussen lesings bereken word, om onder meer te bepaal of die pompe doeltreffend werk.

Om die beheerstelsel meer akkuraat te maak, word 'n waarnemingsboorgat tesame met 'n nabygeleë kontrole-waarnemingsboorgat ook drie maal per week in elke gebied gelees. Sodoende kan die effek van die ontwatering op die korttermyn gemoniteer word.

Wanneer die pomptempo vir ten minste drie maande konstant gehou is, kan 'n betroubare syfer vir spesifieke lewering bepaal word.

Met behulp van 'n betroubare lewering, word 'n ontwateringsplan opgestel. Dit word op die langtermyn mynbouafboubeplanning gebaseer wat jaarliks hersien word.

Vir elke nuwe ontwateringsplan word die spesifieke lewering met behulp van die nuutste beskikbare gegewens hersien.

Volgens mnr Bissett ken hulle die kompartement na 11 jaar nou al so goed dat hulle presies kan voorspel hoe die ondergrondse watervlak op sekere pomptempo's gaan reageer. Hierdie voorspellings word afgelei van grafieke waarop die vroeëre reaksies van die grondwater in die kompartement aangebring is. Die voorspellings is volgens mnr Bissett tans meer betroubaar en akkurater as enige voorspellings wat met rekenaarmodelle verkry is.

Die water wat Yskor by die myn uitpomp, is geproklameerde water en behoort na regte aan die Staat. Tog is daar geen beperking op die hoeveelheid water wat hulle mag onttrek nie. Al die oortollige water wat nie op die myn self gebruik word nie, word na die dorpe Sishen-Kathu en via die Vaal-Gamagarapypyplyn na Hotazel en Olifantshoek gepomp.

'n Deel van die water wat na Sishen en Kathu gepomp word, gaan eers na 'n versagtingsaanleg waar die water behandel word om dit vir huishoudelike gebruik geskik te maak.

Volgens mnr Bisset kos dit Yskor nagenoeg 8 c/m^3 om die water uit die groef te pomp. Hierdie prys sluit die pompe, arbeid en krag in, maar nie die kapitale uitleg vir die sink van die boorgate en die bou van die pypleidings nie. Laasgenoemde was baie hoog. Die pyplyn wat die myn, byvoorbeeld, na Kathu-dorp gebou het, het Yskor R45 per meter vir die materiaal alleen, sonder arbeid, gekos. Koste verbonde aan die sink van die boorgate was tussen R400 en R500 per meter.

Die water word vir 8 c/m^3 aan die Departement van Waterwese en vir 6 c/m^3 aan Sishen-Kathu verkoop.

Volgens die Stadsklerk van Sishen-Kathu, mnr Sakkie van der Vyver, verkoop die munisipaliteit die harde water vir 20 c/m^3 en die behandelde sagte water vir 22 c/m^3 aan die inwoners van die dorp — seker van die goedkoopste water in Suid-Afrika.

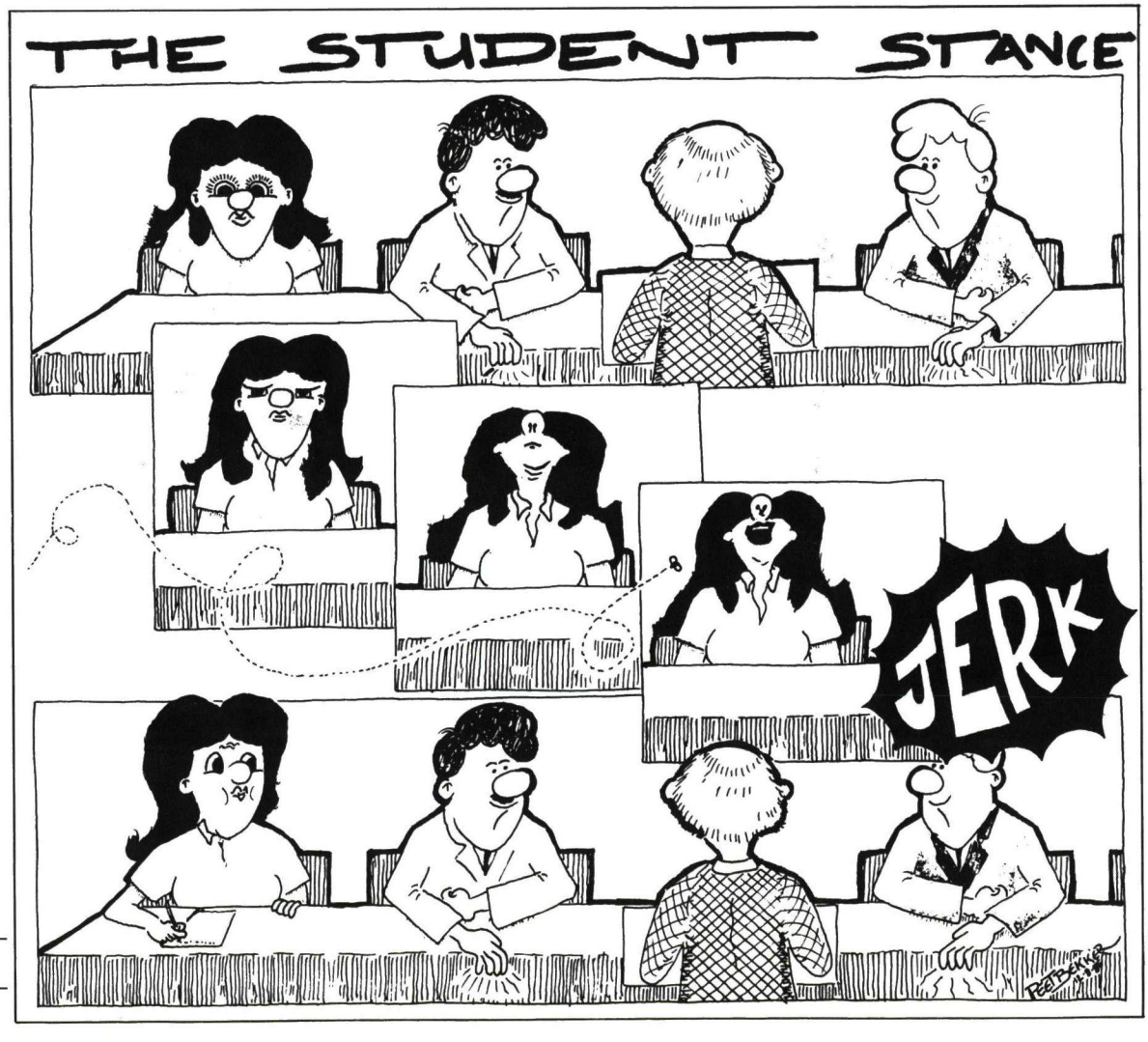
JERK OF THE CONGRESS AWARD

Paying tribute to all somnolescent symposiasts

During the annual Congress of the Limnological Society of Southern Africa in Windhoek this year, it occurred to some members of the Society that many delegates at Congresses and Symposia make subtle contributions to the proceedings that go completely unrecognised and unrewarded. An ad hoc and totally unofficial Committee was thus formed to look into the situation, and this Committee made a strong recommendation that a further Society award be introduced. The award will recognise the subtle skill exhibited by delegates in falling asleep unnoticed during sessions. The award has been named the ''Jerk of the Congress Award'', in order to highlight that moment of supreme burn-up of energy that occurs as delegates jerk awake after having dozed-off. The award was assembled using the contents of several dust-bins, and consists of a pod of the camel-thorn tree, *Acacia erioloba,* sensitively mounted on a chain of plastic pearls, using twice used sellotape.

Studies by sociologists have revealed that the jerk is the end result of three basic stances adopted by delegates during sessions:

- ☐ *The Student Stance.* This is an unsophisticated stance common among younger delegates. The delegate falls asleep sitting bolt upright, with hands resting loosely in the lap. The head gently falls backward and the mouth begins to open This process continues until a sudden input — which might be a pain in the neck, a tippling chair or a fly in the mouth — causes the sleeper to jerk awake.
- ☐ *The Poised-pen Stance.* This variation is favoured by the majority of seasoned delegates. One elbow is placed on the table, the fore-arm is lifted and, with outspread fingers, the hand supports the head. A pen is wedged in the other hand and poised over a pad of paper with some writing on it. The jerk occurs as the pen clatters from the lifeless hand.
- ☐ *The Bleeding Eyes or Black Heron Stance.* This variation first becomes apparent on the second



NATIONAL INSTITUTE FOR WATER RESEARCH
INSTITUTE OF WATER POLLUTION CONTROL
WATER RESEARCH COMMISSION
DEPARTMENT OF WATER AFFAIRS

S Y M P O S I U M

ON

WATER FOR THE FUTURE

C S I R CONFERENCE CENTRE : PRETORIA

31 OCTOBER 1986

PROVISIONAL PROGRAMME

07h45 - 08h45	:	**Registration**
08h45 - 09h30	:	**Keynote address** **MR J G DU PLESSIS** : Director General, Department of Water Affairs
09h30 - 10h00	:	**Water demand and availability** **MR T P C VAN ROBBROECK** : Managing Engineer, Water Resources, Department of Water Affairs
10h00 - 10h30	:	**Water Management : policies and strategies to meet future requirements** **MR G C D CLAASSENS** : Deputy Director General, Department of Water Affairs
10h30 - 11h00	:	**T E A**
11h00 - 11h30	:	**Water Management : the legislator's role** **MR W A LABUSCHAGNE** : Director, Law Administration, Department of Water Affairs
11h30 - 12h00	:	**Water Management : data acquisition and decision support systems** **DR C P R ROBERTS** : Manager, Scientific Services, Department of Water Affairs
12h00 - 12h30	:	**Financial and manpower requirements** **MR N M KRIGE** : Managing Engineer, Works, Department of Water Affairs
12h30 - 14h00	:	**L U N C H**

14h00 - 14h30	:	**Water quality trends** **DR D F TOERIEN**, Chief Director and **DR D C GROBLER**, NIWR
14h30 - 15h00	:	**Water Management : water quality control** **MR H J BEST** : Managing Engineer, Water Quality, Department of Water Affairs
15h00 - 15h30	:	**T E A**
15h30 - 16h00	:	**Water Research** **MR P E ODENDAAL** : Chief Executive Officer, Water Research Commission
16h00 - 16h30	:	**Wastewater reclamation and reuse** **DR L R J VAN VUUREN**, Director, NIWR **DR W H J HATTINGH**, Chief Adviser, Water Research Commission
16h30 - 16h50	:	**Discussion forum**
16h50 - 17h00	:	**Closure**
17h00 - 18h30	:	**Cocktail party**

---ooOoo---

To attend this Symposium, simply complete and return the attached registration form. The registration fee of **R50** entitles delegates to full papers, morning and afternoon tea or coffee, lunch and a cocktail party.

Please note that your registration fee should accompany your completed registration form. Cheques should be made payable to the National Institute for Water Research, S405 and sent with your form to the Chief Director, NIWR, P O Box 395, Pretoria 0001.

SYMPOSIUM ON WATER FOR THE FUTURE, S405

CSIR Conference Centre, 31 October 1986

Name (Prof./Dr/Mr/Mrs/Miss): .....
(Block capitals please)

Organization: .....

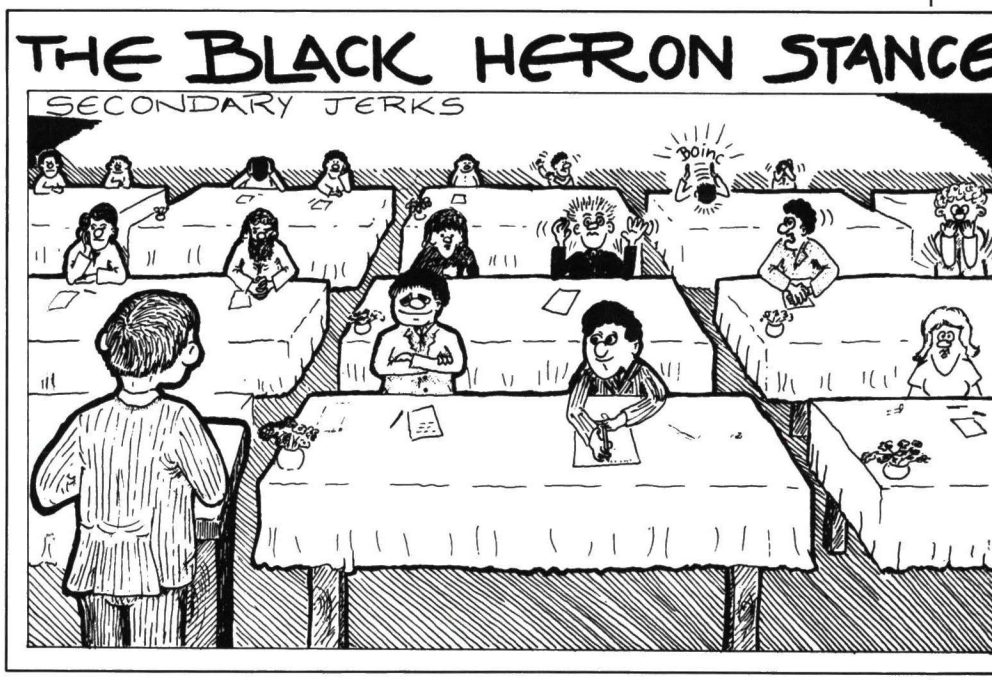
Postal address: .....

Postal code: ..... Telephone number: .....

My cheque for R50 made payable to the National Institute for Water Research, S405, is enclosed.

day of Congresses, and increases in popularity to become the most commonly adopted stance by the fourth or fifth day. Both elbows are placed on the table, fairly far apart, both fore-arms are lifted and the head is supported between the two outspread hands. In this position the face is totally invisible from the back, the front and both sides. As the delegate dozes off the head starts to slide down between the hands. The jerk occurs fractionally before or fractionally after the face hits the table.

This stance is of special interest because the noise of the impact triggers off secondary jerks. If one is looking in the right direction as the delegates hits the table, one witnesses a remarkable ripple effect of secondary jerks in a circle of diameter 5 m around the primary jerk.



Members of the ad hoc, unofficial, non-permanent sitting Committee on Gongs deliberated at length on the awarding of this prestigious gong, and finally reached consensus. Against stiff competition, the runners-up were Drs. Bryan Davies and Danny Walmsley (who were, nevertheless, later disqualified on a technicality when it was verified that on one occasion they actually propped each other up, in order not to jerk) and Dr. Mark Chutter who, with consummate skill, moved through a series of sleeping and waking episodes without one discernible snore, twitch or jerk. However, their efforts paled beside those of our two winners. We watched with awe as one of these provided us with a new all-comers record by dozing off during the Presidential Opening Address, ten minutes into the Congress and, in order to show that this was no fluke show of form, went on to produce a number of jerks of quite outstanding stature and vigour during the remainder of the Congress.

Our other winner was a late nomination, but moved swiftly up through the field solely on the strength of his magnificent performance on the third day of the Congress, when he slept through the entire A.G.M. including the part when he gave his portfolio report.

It is thus with great pleasure that we presented this prestigious gong — the 1986 Jerk of the Congress Award — to our joint winners, Miss Barbara Stewart of U.C.T. and Dr. Peter Ashton of N.I.W.R.

signed **Drs. Jackie King and Jay O'Keeffe, Gongs Committee**

Footnote. The above is largely a figment of our imagination. It is offerred (and hopefully received) in a spirit of fun and in acknowledgement of the great camaraderie that exists at all L.S.S.A. Congresses.

NEW DEVELOPMENT IN WATER TREATMENT

The clarification of water through the processes of chemical dosing and filtration has received the attention of innovative engineers, and non-engineers alike, for over a hundred years. Every now and again a new idea hits the jack-pot and sets new standards such as Imoff and Bardenpho.

Two Benoni engineers Messrs Richard Batson and Peter Chapman are quite confident that their new separator for liquid filtration is the most significant new development in water filtration for years.

The removal of colloidal particles has traditionally been done by using various configurations of flocculators, settlers and sandfilters.

"Now," say Messrs Batson and Chapman, "all of these processes can be replaced by our floating media separator. It overcomes many of the problems experienced with the traditional approach such as the tendency to clog filters, the instability of sludge blanket clarifiers and insufficient back-washing without creating any new problems."

The system uses a vertical flow tank with a conical bottom for sludge collection. The filter media is retained near the top of the tank and the fluid to be filtered pushes upwards through the media retaining even the very finest colloidal particals such as carbon black which is considerably finer than coal duff.

"The media causes a completely uniform upward flow velocity over the whole cross section of the tank," Messrs Batson and Chapman says. "This enhances the conditions for attachment of the sub-micron suspended particles to the media caused by the difference in charge. A layer of suspended solids gradually builds up underneath the floating media. Due to the low compaction in this area, this coating remains fairly open and a high pressure drop is avoided."

To rejuvenate the filter media, the process is stopped and either water or compressed air can be injected to break the layer of fine solid particles entrapped by the floating media.

Filtration can be resumed after about fifteen minutes once conditions have stabilised.

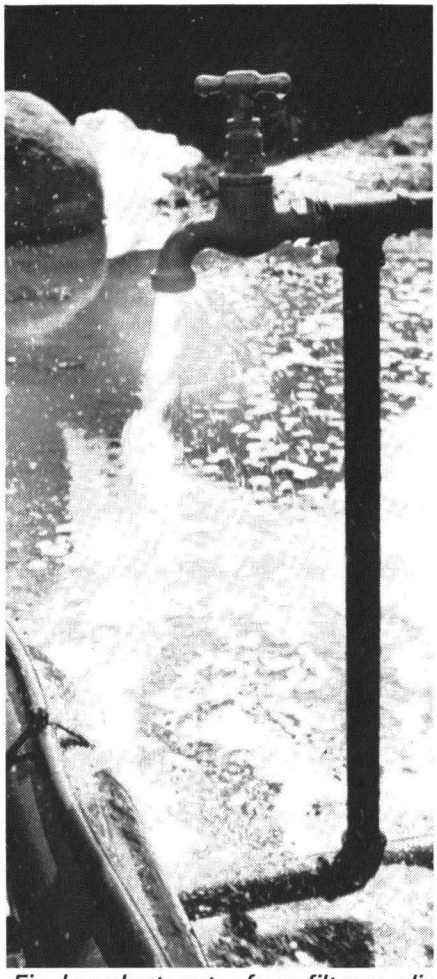
When used for the tertiary treatment of sewage effluents, the major proportion of its sludge consists of calcium phosphate. The latter being an excellent soil conditioner is sought after by farmers thus also solving a disposal problem.

One of the processes in the pretreatment of effluent is time dosing. Present techniques often result in blockages in the pumps and piping. Messrs Batson and Chapman have, therefore, also desinged a new method of obtaining a saturated lime solution or a fine suspension of lime for delivery to the mixing tank.

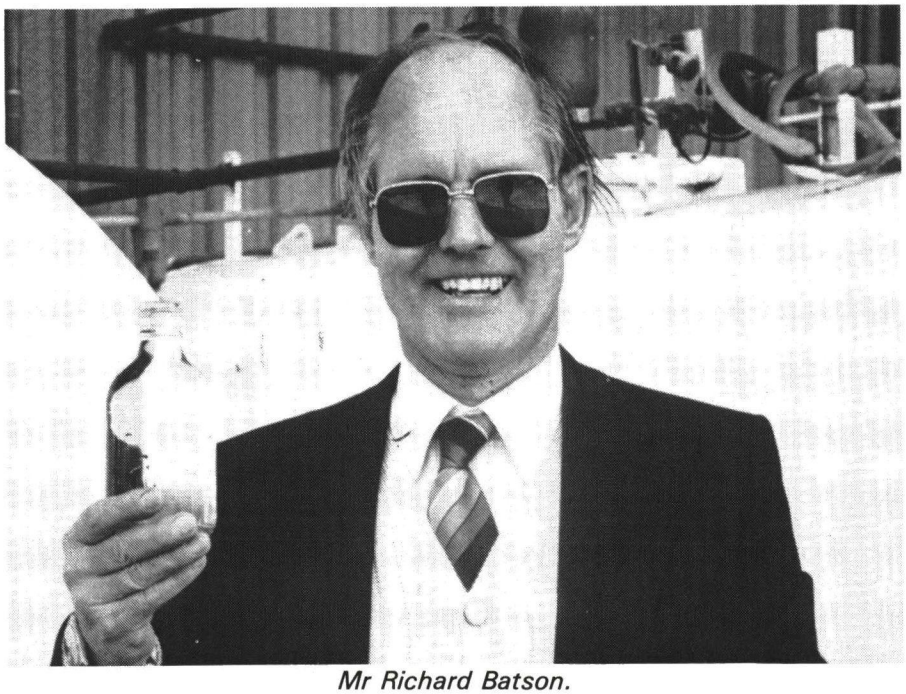
Using fan shaped water jets, water is injected horisontally into the mass of lime, fluidizing and dissolving the lime mass resulting in a fine suspension of lime particles, in a saturated solution, for feeding to the mixing tank.

Capital costs are low, blocking and packing are minimal and very accurate control can be maintained.

For further information contact: Water Renovation (Pty) Ltd, PO Box 13111, Northmead, 1511. Telephone: 54-4873/4.



Final product water from filter media separator.



Mr Richard Batson.

Satelliet kliek moontlike boorgate

Britse geoloë het met foto's wat uit die ruimte geneem is belowende plekke vir die sink van varswaterboorgate in die droogtegeteisterde Eritrea en Soedan opgespoor. Hierdie tegniek is vinnig en goedkoop en volgens die Britse radiodiens, BBC, kan dit 'n handige wapen word in die stryd teen natuurlike rampe oor die hele wêreld heen.

Met goeie geologiese kaarte wat die dreineringstelsels in detail beskryf asook aantoon watter soort rotsformasies waar voorkom, is dit relatief maklik om belowende plekke vir nuwe boorgate aan te toon wat genoegsame hoeveelhede varswater sal lewer.

Die probleem in baie dele van die wêreld, insluitende Eritrea en Soedan, is dat daar glad nie sulke kaarte bestaan nie en om hulle met standaard landmetingstegnieke op te trek, is 'n stadige en 'n duur proses.

'n Groep Britse wetenskaplikes is vol vertroue dat hulle 'n eenvoudige en 'n goedkoop manier gevind het om dié problem op te los.

Dr Steve Durry en sy medewerkers in die departement van aardwetenskappe aan die *Open University* in Brittanje is al vir 'n geruime tyd besig om foto's uit die ruimte vir geologiese werk te gebruik. Hulle het besef hulle kon hulle kundigheid inspan om satellietfoto's te interpreteer en op dié manier 'n bydrae lewer om die droogteprobleem in die Horing van Afrika te help verlig.

Wat hulle baie gehelp het, was 'n uitstekende stel foto's van die gebied wat tydens 'n onlangse Nasa-ruimtesending met 'n spesiale grootformaat kamera geneem is. Die negatiewe is 45 by 22 sentimeter groot, ongeveer 100 keer groter as die negatiewe van 'n gewone 35 mm kamera. Nasa stel die negatiewe vrylik beskikbaar teen die weggeeprys van 25 dollar elk.

Dr Durry het slegs vyf negatiewe nodig gehad om die hele Eritrea en die grootste deel van die Soedan te dek. Hy beskryf die foto's as ''ongelooflik akkuraat''. Met die foto's kan strukture op die grond tot so klein as vyf meter in deursnee geïdentifiseer word.

Die foto's wys elke detail van die natuurlike dreineringstelsel, terwyl rotsformasies maklik uitgeken kan word. Topografiese kenmerke soos heuwels, droë rivierlope, leegtes, ens. is ook duidelik sigbaar. Dit is presies die soort inligting wat geoloë benodig om te bepaal waar water onder die grond vasgevang is.

Dr Durry se span het die 100 belowendste plekke vir toekomstige boorgate in Eritrea en Soedan geïdentifiseer. By die keuse van elke plek het die wetenskaplikes die toeganklikheid van die terrein in ag geneem asook hoe geskik dit vir boerdery en dus vir die permanente vestiging van mense is. Hierdie inligting word aan die Eritreaanse Noodlenigingsvereniging oorhandig.

Hulle sal al die plekke besoek om te kyk of die wetenskaplikes se voorspellings van ondergrondse water korrek is. As dit wel so is, is dit baie maklik om 'n boorgat te sink of 'n put te grawe aangesien al die toerusting agter op een vragmotor vervoer kan word.

Die feit dat daar eers in Oktober 1985 met hierdie projek begin is, bewys hoe vinnig en goedkoop hierdie soort geologiese opname gedoen kan word. Indien dit wel lei tot 'n honderd of wat nuwe watergate vir die droogtegeteisterde Horing van Afrika kan die metode homself bewys as een van die mees koste-doeltreffende maniere van noodleniging wat nog gebruik is.

Aangesien Pendeltuigvlugte deesdae gereeld plaasvind, en die ruimtefoto's so goedkoop en vrylik beskikbaar is, is daar geen rede waarom dieselfde tegnieke nie in ander dele van die wêreld gebruik kan word nie. Dr Durry se inisiatief tesame met Nasa se tegnologie kan gevorderde afstandwaarneming binne die bereik van die meeste behoeftige lande en noodlenigingsorganisasies plaas.

FOKUS OP SKUIMVORMING BY GEAKTIVEERDESLYK-STELSELS

Die beheer van biologiese skuim in geaktiveerdeslyk-stelsels is deur mnr Chris Laubscher, 'n student aan die Universiteit van Pretoria, in sy doktorale studie ondersoek.

Die doel van die navorsing, wat deur die Waternavorsingskommissie gefinansier is, was om meer inligting oor biologiese skuimvorming te bekom en metodes te ondersoek om skuimvorming te voorkom of te beheer.

''Verskeie metodes is al in die verlede toegepas ten einde biologiese skuim in geaktiveerdeslyk-stelsels te beheer of te onderdruk, maar met beperkte sukses'' sê mnr Laubscher.

In die studie is vasgestel dat biologiese skuim vorming deur die teenwoordigheid van draderige mikro-organismes van die *Nocardia* en *Microthrix parvicella*-spesies veroorsaak word. Hierdie organismes beskik oor eienskappe wat dit moontlik maak om hulle selektief uit die slykmengsel te flotteer en daardeur skuimvoorkoms te beheer. Verder is daar ook 'n metode ontwikkel waardeur die skuiminhoud in geaktiveerdeslyk-stelsels gekwantifiseer kan word.

Mnr Laubscher sê 'n koste-doeltreffende metode vir skuimverwydering is ontwikkel. Daar is ook 'n wiskundige model ontwikkel wat die tempo van skuimverwydering uit 'n stelsel in terme van verskillende bedryfsparameters beskryf. Hierdie metode en model is uiteindelik suksesvol getoets op volskaal by Pretoria se Daspoort Rioolwatersuiweringswerke sowel as by die Benoni-Rynfield Rioolwatersuiweringswerke.

QUOTE OF THE CENTURY

And Noah he often said to his wife when he sat down to dine, ''I don't care where the water goes if it doesn't get into the wine.''
(Gilbert Keith Chesterton: 1874 – 1936).

EDITOR'S S O S

In her book, *Editing Scientific Books and Journals,* the senior editor of Ciba Foundation in London, Maeve O'Connor poses the question whether scientists who become editors can stay sane. Her verdict in the words of PH Mann: "to get the single author to write to a deadline is bad enough; to have an academic editor trying to whip-in a dozen prima-donna professors is a recipe for a nervous breakdown".

Are models a yes-yes?

How frequently are mathematical models used in water resources planning, design and operation and what are the major constraints facing future use? T Al Austin, director of the IOWA State Water Resources Research Institute, conducted a survey in which he addressed these questions.

According to the *Water Newsletter* over half the questionnaires were returned. The newsletter continues to say that the survey found that 95 per cent of the private consultants are currently using modelling for planning, design and operation of water resources systems. From the state agencies 84 per cent reported to be using models.

About 40 per cent of the models being used by both sectors were developed in-house. The most widely used were: surface water hydrology models, 62 per cent; surface water quality models, 48 per cent; channel and tidal hydraulic models, 48 per cent; and reservoir systems models, 45 per cent. About 63 per cent said model results had an important influence on certain projects, and more than half believe there will be a significant increase in model use in the next five years.

When asked to rank several obstacles limiting the use of models, state agencies ranked inadequate data first, while consultants chose inadequate project funding as more of a constraint.

(Water Newsletter, March 31, 1986)

HOE OM WATER TE BESPAAR

'n Wenk of twee aan die huisgesin

NOU BESKIKBAAR

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Adres .....

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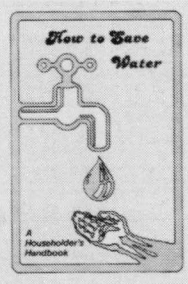

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ADAPT OR DIE

WATER CURBS NECESSITATE CHANGES IN GARDENING ATTITUDES

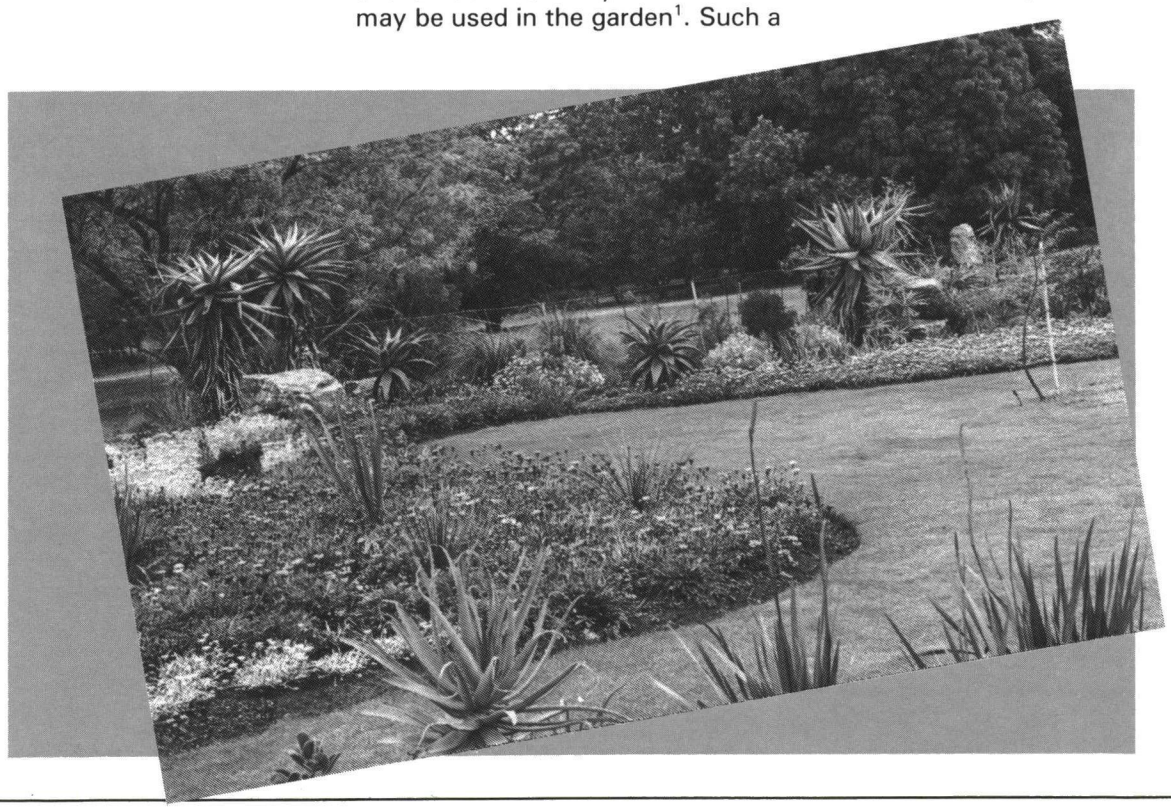
A water-economy garden and a control garden established by the National Building Research Institute (NBRI) of the CSIR have successfully established that garden water requirements can be reduced. The garden demonstrated the use of drought-resistant plants, mulches, and the application of micro-irrigation systems, as well as quantified the water savings achievable with a water-conserving garden when compared to conventional gardening. In the following article Mr George Malan, Senior Engineer at the NBRI, describes the project and irrigation management techniques they used. He also deals with the results obtained.

INTRODUCTION

In our towns and cities the water used for developing and maintaining both domestic gardens and municipal parks is largely drawn from the domestic potable water supply. Under normal conditions (without water restrictions) some 25 to 55 per cent (depending on the climate) of the water drawn by a householder may be used in the garden[1]. Such a garden suffers when water restrictions come into force.

In South Africa with its recurrent droughts, it is essential that the use of water for gardening be fully optimised.

During the 1970s, when a severe drought occurred in the Western United States, several demonstration water-economy gardens were developed, using drought-resistant



plants. Researchers in one Californian investigation found that such gardens required up to 60 per cent less water than the conventional types[2].

NBRI PROJECT DESCRIPTION

A water-economy garden, and an adjacent control garden, were established by the National Building Research Institute (NBRI) during 1983 on the CSIR's Scientia campus in Pretoria, as part of a research project into water economy measures in urban areas. This project was funded by the Water Research Commission.

Objectives for the garden project were:

- ☐ to demonstrate the attractiveness and variety of drought-resistant plants available in South Africa;
- ☐ to demonstrate the use of different types of mulch on open areas between plants and shrubs;
- ☐ to demonstrate micro-irrigation systems; and
- ☐ to quantify the water savings achievable with a water-economy garden, when compared with a more conventional garden.

Details of the project gardens are given in Table 1.

The plants used in the economy garden are included in a list drawn up by Mrs DMC Fourie of the Botanical Research Institute[3].

IRRIGATION

As the investigation was primarily aimed at the domestic garden, it was decided to employ unsophisticated methods of irrigation. The quantity of water to be applied during an irrigation cycle was established by first determining the moisture capacity of the sandy loam soil (120 mm of water per m^3 of soil). In order to replenish the moisture in the top 100 mm of soil (which was allowed to dry out between waterings) a minimum of 12 mm of water was required. In order to provide this quantity and to compensate for sprinkler evaporation loss and the natural unevenness of application, 19 mm was applied each time.

The state of the top 100 mm of soil and hence the necessity to water, was monitored for both gardens using a portable voltaic-cell moisture indicating probe, as well as by observing the general condition of the plants and grass. The probe was pushed into the soil at several places. When the needle on the dial of the probe dropped to a predetermined point on a graduated scale, it was time to irrigate. The quantity of water applied was recorded by means of water meters.

The water supply system for the economy garden incorporated an automatic shut-off metering valve, and an in-line filter for the drippers. Because of the high supply pressure, a 100 kPa pressure-control valve was required for the micro-sprinklers and misters. This valve was set at 80 kPa to limit the throw of the sprinklers.

Two 400 kPa pressure control valves operating in parallel were used for the sprinklers in the control garden.

RESULTS

A summary of the recorded results over a 12-month monitoring period ending 15 September 1985 is given in Table 2.

CONCLUSIONS

The following conclusions have been drawn from the investigation:

- ☐ In terms of water applied per unit area, the economy garden required 30,6 per cent less than the control garden. The potential of water conserving gardening is thus established.
- ☐ Watering was required less often by the economy garden than by the control garden, particularly in winter.

The reasons for the lower water requirements of the economy garden are believed to be a combination of:

- ☐ the exclusive use of drought-resistant plants and grass;
- ☐ the use of mulches; and
- ☐ the beneficial moist micro-climate created by the micro-irrigation system. This conclusion is based on a comparison of the condition of the plants in both gardens.

The economy garden created a favourable impression on all visitors who inspected it. It is hoped that plant nurseries will acquire more, and promote the greater use of, drought-resistant plants and grasses in this country.

References;

1. MALAN, GJ. Water economy — the worthwhile goal. NBRI Publication R/BOU 1195 (1984).
2. CALIFORNIA DEPARTMENT OF WATER RESOURCES. Water conservation in California. Bulletin 198, May 1976.
3. FOURIE DMC. A preliminary list of plants for water conserving gardening in South Africa. Botanical Research Institute, Bulletin No 402.

Area under irrigation (m^2)		Irrigation systems		Types of plants		Types of mulch	
Economy garden	Control garden	Economy garden	Control garden	Economy garden	Control garden	Economy garden	Control garden
Beds: 948 *Lawn:* 222	*Beds* and *Lawn:* 1 108	*Beds:* 62 micro-sprinklers, 4 micro-misters and 12 on-line drippers. *Lawn:* 4 impact-drive sprinklers.	5 impact-drive sprinklers	Drought-resistant indigenous ground covers, shrubs and trees; also succulents and 4 drought-resistant lawn types.	Mixture of drought-resistant and less drought-resistant plants and shrubs. Less drought-resistant lawn (Kikuyu)	Bark and wood chips, decorative pebbles and plastic sheet covered with 50 mm of soil	No mulch

TABLE 1: Details of the water conserving and the control gardens.

Garden	Data Number of times watered Summer	Winter	Average interval between waterings (days) Summer	Winter	Average quantity of water per application (mm)	Total quantity applied (mm)
Economy	16	8	15,0	15,4	19,3	463
Control	22	13	11,0	9,5	19,1	667

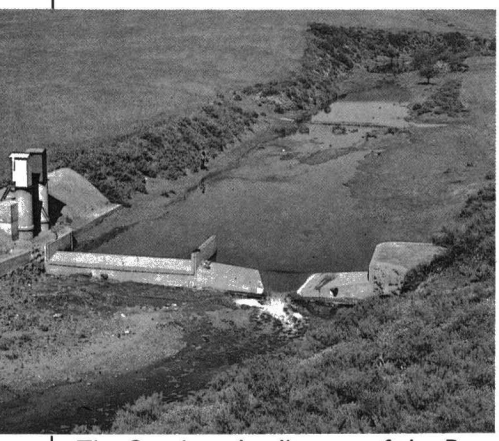
NOTE: Measured rainfall: Winter (May-August) 59 mm
Summer (September-April) 573 mm

TABLE 2: Summary of results for year ending 15 September 1985.

SALINITY NEWS

During the last three years the Hydrological Research Institute has, on behalf of the Department of Water Affairs, undertaken a number of investigations into existing and envisaged water resource salinity problems.

The purpose of SALINITY NEWS is to provide scientists, engineers and interested persons with a regular update of the scope and status of the Institute's salinity research. Further information on any of the projects and reports referred to in SALINITY NEWS can be obtained from:
The Director,
Hydrological Research Institute,
Private Bag X313, Pretoria 0001.



The Sandspruit tributary of the Berg River catchment. Typical salinities are of the order of 4 000 — 6 000 mg/ℓ TDS.

SALINITY RESEARCH IN DRYLAND AGRICULTURAL CATCHMENTS

In 1983 the Hydrological Research Institute launched a research project aimed at continuing the valuable work started by Dr JM Fourie of the National Institute of Water Research (Bellville) in the late 1970s, on the movement of solutes in the dryland agricultural areas of the Berg River.

An understanding of the relevant processes was of particular importance to the Department of Water Affairs for two reasons. Firstly, the hydro-salinity modelling programme of the Berg catchment (see *Salinity News* in *SA Water Bulletin,* May 1986) was in need of process information to refine the routines dealing with salt generation and transportation. Secondly, the saline streams draining the dryland agricultural areas of the Berg catchment downsteam of Paarl, constitute a major threat to the quality of water supplied to the Saldanha-Vredenburg area. This water is drawn from the lower Berg River at the Misverstand Weir. It is intended that future supplies to Atlantis be abstracted at the same location.

The tributary selected for dryland salinity research was the Sandspruit draining an area of 150 km^2 on the west bank of the Berg River. Landuse largely comprised winter wheat and pasture grown mainly on shallow soils overlying weathered shales of marine origin. The catchment was equipped with a new Crump weir near its confluence with the Berg River, continuous stage and electrical conductivity recording instrumentation, automatic pump samplers, soil moisture probes, a rain gauge network and a weather station.

The aims of the research project were the identification of the primary source areas of salts in the catchment and an estimation of their respective contributions to the total salt yield, a description of the dynamics of salt transport through the catchment, and an analysis of the variations in stream salinity with respect to rainfall events and time of year.

Despite initial problems relating to the acquisition of good quality data from electronic instrumentation, a considerable amount of information has been collected and processed. One of the more important consequences of the research has been the insight into the variation in salinity response of the catchment both during isolated high flows and throughout the entire rainfall season. This has subsequently led to a major re-evaluation of the sampling frequencies associated with those monitoring programmes aimed at estimating salt loads.

Winter 1986 will be the last season for which intensive data collection is carried out in the Sandspruit. Future research on this topic will concentrate on the investigation and comparison of salinity processes in other catchments.

BESPROEIINGSIMPOSIUM IN DIE PYPLYN

Besproeiing in die Suid-Afrikaanse land- en tuinbou is die tema van 'n simposium wat op 1 Oktober by Hunter's Rest Hotel in Rustenburg gehou word. Die simposium word deur die Misstofvereniging van Suid-Afrika gereël.

Onderwerpe wat gedek sal word is: die beskikbaarheid van oppervlakte — en grondwater met spesiale verwysing na die benutting in landboumoontlikhede en — beperkings; aanwending van toepaslike besproeiingstelsels; evaluering van waterkwaliteit vir besproeiingsdoeleindes; gewaskeuse in die lig van ekonomiese waterverbuik; bemesting en oesbeskerming deur besproeiingstelsels.

Bywoning van die simposium is gratis en sluit 'n middagete in.

Navrae: Mev L Vosloo, MVSA, Posbus 1821, Pretoria 0001. Telefoon: (012) 28-3642, voor 26 September 1986.

URBAN HYDROLOGY AND DRAINAGE: REPORTS AVAILABLE

A research project on urban hydrology and drainage, under the direction of Professor David Stephenson of the Water Systems Research Programme at the Witwatersrand University, has recently been completed.

The main objectives were to produce design guides for hydrologists and engineers concerned with the determination of floods in urban and small catchments and for the design of drainage systems.

Owing to high rainfall intensities experienced and high surplus runoff, the kinematic method was found to be the most appropirate.

WITWAT is a micro-computer model developed primarily for the design of storm drain networks, but can also be used in analysis mode for management or research purposes.

The design guide for estimating peak stormwater runoff and the effects of urbanisation has been published in report form and is available from the Water Research Commission free of charge.

TO PAY OR NOT TO PAY

In a nationwide drinking water survey in September 1985 the American Water Works Association (AWWA) Research Foundation found in a survey that more or less two in three respondents felt that there is a need for more water research. Of those 64 per cent were willing to pay higher water rates to support such research.

Other findings include that:

- ☐ nearly 13 million households used bottled water in addition to tap water;
- ☐ of those rating their water quality as average or below, 24 per cent believed it contained harmful contaminants with chlorine being the most frequently named contiminant, though chlorine is deliberately dosed into the water to disinfect it.

(World Water, April 1986).

ON WHEELS: PURIFICATION SETS

Transportable! First it was your radio, then your television set and now it can by our own lightweight purification set.

According to a recent issue of *Enfo,* a British manufacturer developed a range of transportable and trailer-mounted purification sets which can produce drinking water from paractically any natural source of fresh or sea water.

"Initially designed for the British armed forces, the units are well suited to civil-emergency situations such as flood and earth-quake disasters, and for meeting the needs of temporary hospitals, expeditions, isolated villages, farming enterprises, construction gangs and exploration crews," *Enfo* says.

(Enfo Vol 8, No 1, February 1986)

Prof en mev Rooseboom in Pole.

SA Prof in Pole

Prof Albert Rooseboom van die Departement Siviele Ingenieurswese, Universiteit Pretoria, en sy vrou Elbé het gedurende Junie vanjaar die voorreg gehad om Pole en Italië te besoek.

Danksy 'n amptelike uitnodiging aan prof Rooseboom om 'n referaat by 'n simposium te lewer, is visums deur die Poolse regering aan die egpaar uitgereik. Hulle is baie gul ontvang en het 'n toer deur die suide van Pole meegemaak. Die simposium was in Krakow, die geskiedkundige oudhoofstad van Pole, gehou. Daar was ook geleentheid om die grafte van 47 Suid-Afrikaanse lugmagmanne wat in Krakow begrawe is te besoek.

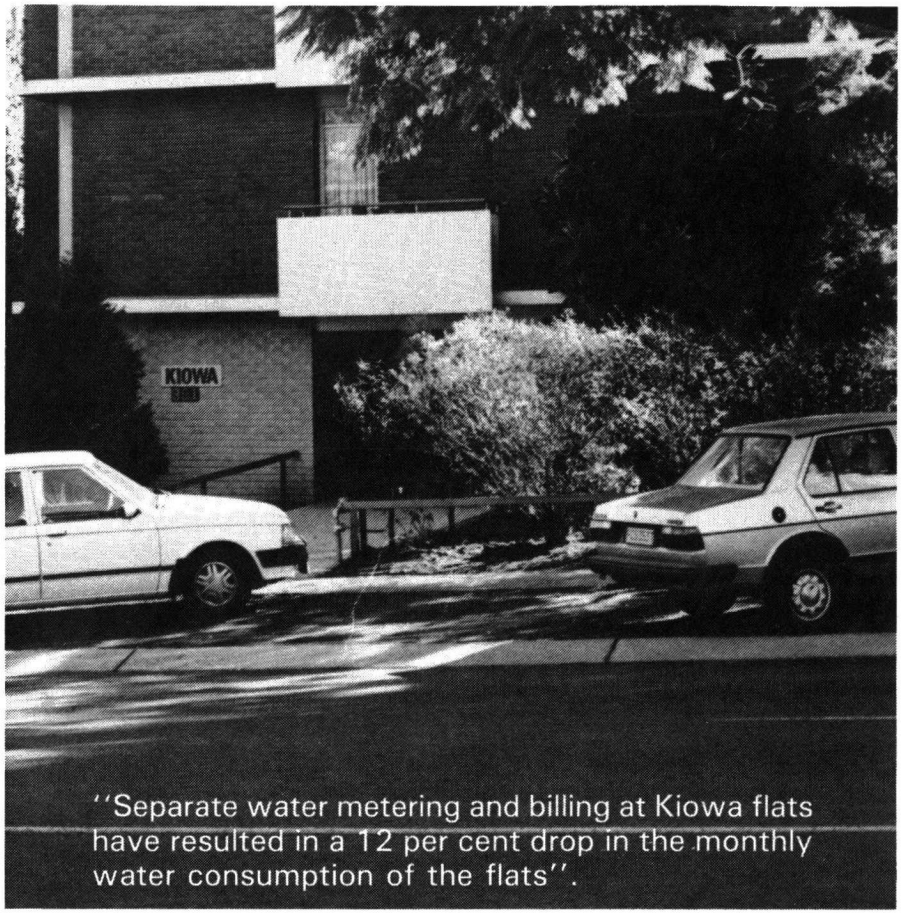
Na afloop van die besoek aan Pole, het prof Rooseboom as gasspreker opgetree by 'n simposium van Italiaanse navorsers op die gebied van sedimentvervoer en erosie. Hierdie simposium is in Bologna, Italië, gehou.

ENVIRONMENTAL GEOLOGY AND WATER SCIENCES

a new international journal

South African authors are invited to submit scientific articles pertaining to any aspect of geology, hydrogeology and the environment for publication in this new journal published by Springer Verlag in Germany.

For more information write to the Editor-in-Chief, Dr PE La Moreaux, PO Box 2310, Tuscaloosa, Alabama, USA 35403.



"Separate water metering and billing at Kiowa flats have resulted in a 12 per cent drop in the monthly water consumption of the flats".

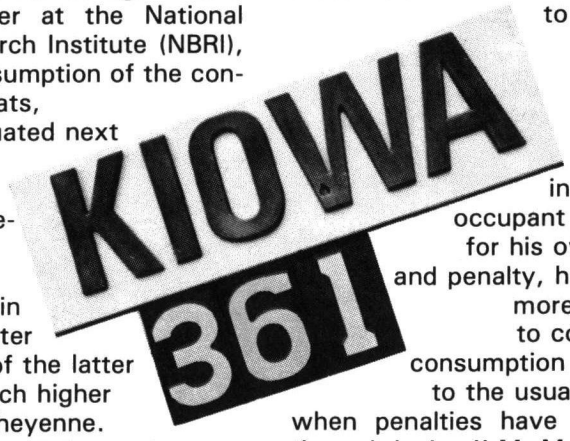
Separate water metering and billing at Kiowa flats in Arcadia, Pretoria, have resulted in a 12 per cent drop in the monthly water consumption of the flats.

According to Mr George Malan, Senior Engineer at the National Building Research Institute (NBRI), the water consumption of the control block of flats, Cheyenne, situated next to Kiowa was 19 per cent higher. Before separate water meters were installed in Kiowa, the water consumption of the latter used to be much higher than that of Cheyenne.

The metering of the water consumption of individual flats is part of an investigation being done by the NBRI for the Water Research Commission.

"When we initially indentified the water wasters in Kiowa," Mr Malan says, "there were 14 flats in the penalty tariff areas. Since the project commenced this figure has been reduced to six.

Mr Malan says it has also been found that there were flats that had a monthly consumption of as high as 50 kiloliter per month. In some of these flats the water loss was due to leaking toilets and expansion relieve valves.



"With the individual flat occupant being liable for his own account and penalty, he has much more motivation to control water consumption as opposed to the usual alternative when penalties have to be paid through levies," Mr Malan says.

Apart from analysing the effect individual flat water metering has on the general water consumption of the occupants at Kiowa, Mr Malan says that they will also analyse data from East London as well as overseas countries. They will also be investigating different methods of metering individual flats.

Hulpbronne by kongres bespreek

Die Geassosieerde Wetenskaplike en Tegniese Verenigings van Suider-Afrika in samewerking met die WNNR reël van 12-14 November 1986 'n kongres met die titel Hulpbronne van Suider-Afrika.

Die kongres beoog om die hulpbronne van Suider-Afrika te herevalueer in die lig van ontwikkelinge oor die afgelope dekade. Die moontlike bydrae van die wetenskap en tegnologie om hulpbronne tot voordeel van almal in die streek te benut, sal ook bespreek word.

Die kongres word gehou in die Linden Ouditorium van die Johannesburg College of Education.

Navrae: Simposiumsekretariaat S.400, WNNR, Posbus 395, Pretoria, 0001. Telefoon: (012) 86-9211 × 2286 (mej R Bosua) of × 2077 (mev A Rhodes).

WORKSHOPS TRAIN PERSONNEL

Recently two workshops aimed at training personnel in techniques for the identification of micro-organisms in the activated sludge process, were held in Johannesburg.

The workshops were presented by Mrs Laurraine Lötter, Senior Professional Officer of the City Health Department, City Council Johannesburg, and sponsored by the Water Research Commission.

Mrs Lötter says the workshops assisted researchers in their study of the floc forming bacteria in nutrient removal activated sludge plants.

"As with all scientific methodology, there are constantly innovations in techniques. These workshops are therefore not intended as the last word on this subject. They must be seen as an attempt to share the experiences gained by the Johannesburg City Council researchers over the last three years," Mrs Lötter says.

Further information on micro-organism identification in the activated sludge process can be obtained from Mrs L Lötter, City Council Johannesburg, PO Box 1477, Johannesburg 2000. Telephone: (011) 728-7373.

WATERBEHOEFTES VAN DRIE AKKERBOU — EN DRIE GROENTE GEWASSE

deur PC Nel, HH Fischer, JG Annandale en RE Steynberg.

'n Verslag wat die waterbehoeftes van drie akkerbou- en drie groentegewasse ondersoek is nou beskikbaar. Die verslag is die resultaat van navorsing wat deur die Departement Plantproduksie aan die Universiteit van Pretoria vir die Waternavorsingskommissie gedoen is.

Die verslag wat op die waterbehoeftes van groenbone, kool, tamaties en grondbone konsentreer, is nuttig vir die verfyning van besproeiingskedulering.

Verskillende plantvoedingspeile en -balanse by koring en mielies is ook ondersoek om vas te stel wat die invloed van die balanse op die ekonomiese watervoorsiening van die twee gewasse is. Vanweë die ingewikkeldheid van hierdie faset is dit 'n onderwerp wat tot nou toe min aandag geniet het.

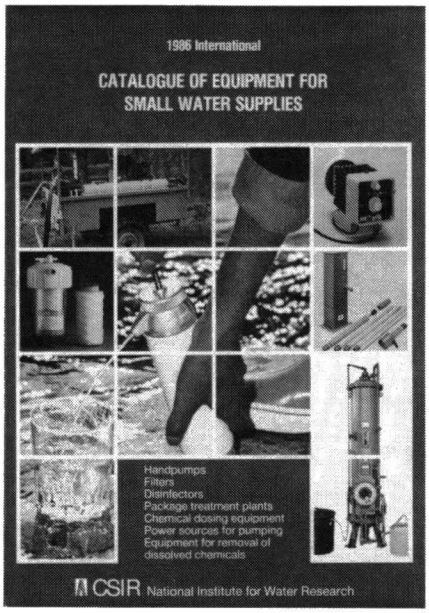
Besproeiingbeplanners sal baat vind by die nuwe kennis oor water- en besproeiingsbehoeftes van veral groentegewasse. Verder vorm die resultate ook 'n goeie basis vir verdere toetsing op plaasvlak waar nodige aanpassings ten opsigte van besondere bestuursvereistes en beskikbare waterverspreidingstelsels waarskynlik gemaak sal moet word.

Prys: Gratis
WNK Verslag nr: 84/1/86
Verkrygbaar van: Die Waternavorsingskommissie, Posbus 824, Pretoria, 0001. Telefoon: (012) 28-5461.

1986 INTERNATIONAL CATALOGUE OF EQUIPMENT FOR SMALL WATER SUPPLIES

Edited by Pawel Sadzik

A wholesome drinking-water is a basic requirement for healthy living conditions and should therefore be an integral part of any community development programme.



The goal of the NIWR's recently established Appropriate Technology Division, as far as water treatment is concerned, is to make the technology available which could be used to enable all communities in southern Africa to enjoy a wholesome drinking-water supply; i.e. to maximize the health benefits to the people at a cost which the community can afford. The Appropriate Technology Division therefore aims to provide technology which is effective, affordable, acceptable and reliable. The Division makes use of available technology where this exists and develops new or improved technology where there are gaps or where no technology exists to meet the needs of a particular situation.

The Divisions collects information on methods and equipment used for protecting small water supplies from contamination and for treating already contaminated supplies. This includes methods currently in use worldwide as well as in southern Africa.

The information collected on equipment for small water supplies has been collated and published as a catalogue, which will be updated annually and is intended to assist engineers and local authorities designing small water supply systems in choosing the most suitable equipment available for their particular applications. The required research and publication of the catalogue was financed by the Department of National Health and Population Development.

Over two hundred items of equipment are featured in the catalogue. These items, collated into categories for ease of reference, include filters, disinfection equipment, hand pumps, power sources for pumping, package water treatment plants, chemical dosing equipment, and equipment for the removal of dissolved chemicals. Each page deals with a single item and comprises a photograph, description and price of the equipment, and telephone number and address of the manufacturer/supplier. In addition alphabetical indexes of equipment and of manufacturers and suppliers, are given.

1986
Price: (Southern Africa) R56,00 (incl)
(Other countries) US $30,00.

ISBN 0 7988 3414 5
Available on prepayment from the National Institute for Water Research, PO Box 395, Pretoria 0001.

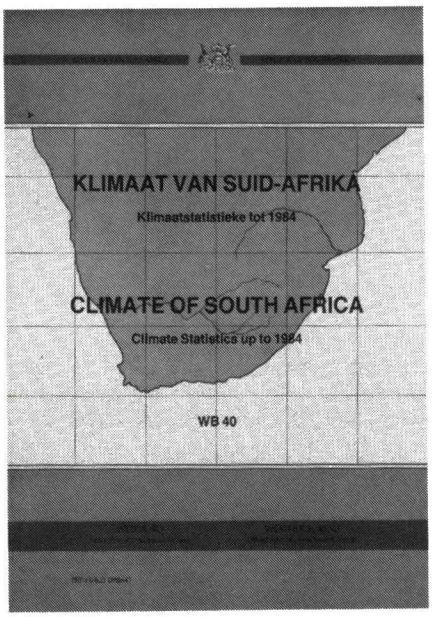
CLIMATE OF SOUTH AFRICA

— Climate statistics up to 1984

compiled by the Climatological Services Division of the Weather Bureau

For nearly three decades the most comprehensive reference work on long-term temperature statistics for South Africa has been the publication, WB 19 — "Climate of South Africa, Part 1, Climate Statistics". This book proved to be very popular but has been out of print for several years.

The new publication, WB 40 — "Climate of South Africa, Climate Statistics up to 1984", is primarily a revision of the temperature, relative humidity, cloud and precipitation summaries based on data given in the previous volume till up to 1950. Furthermore, information on wet-bulb temperatures and the occurrence of snow and fog has now also been included.



It was originally intended that the updated version on the WB 19 publication should contain data up to 1970 and, already by the mid-seventies considerable progress had been made in processing the observations. This involved the transcription by hand of the monthly means from the annual reports between 1951 and 1970 which had been written into the registers. All the post-1970 into special registers in order to calculate the long-term normals. In 1976 the Weather Bureau acquired a powerful main-frame computer and a decision was subsequently taken to make use of the computer to complete the project and also to include all the latest available information.

In order to process the data, the pre-1950 long-term statistics appearing in WB 19 had to be written to magnetic tape, as well as the 20 years' monthly data from 1951 to 1970 data, in the form of the daily 08h00, 14h00 and 20h00 observations, were entered directly into the climatological data bank. The data from these three sources were then combined to provide the statistical summaries.

This new volume, as was the case with the two earlier publications, only contains statistics for those stations where at least maximum and minimum temperature readings have been taken, i.e. the 'climate' stations. Rainfall statistics from purely rainfall-measuring stations are therefore not provided. Data from stations which closed before 1950 have been taken over without change from WB 19. Generally only those stations for which observations are available for at least 5 years have been included — apart from temperature data for some with shorter periods given in WB 19.

The statistics are presented in three tables. Table 1 contains the long-term averages and extreme values of the maximum and minimum temperature; the frequency of occurrence of specified values of the maximum and minimum temperatures; and the mean temperature at 08h00, 14h00 and 20h00. In Table 2 the 08h00, 14h00 and 20h00 mean values of the dry-bulb and wet-bulb temperatures and the corresonding relative humidity are given. Table 3 lists the average and extreme values and frequencies of rainfall, the average monthly occurrences of days with thunder, hail, snow and fog as well as the mean cloud cover at 08h00, 14h00 and 20h00. In total, statistics for 605 stations are given in Table 1, 308 in Table 2 and 376 in Table 3.

1986 474
Price: R50 + GST
ISBN 0 621 098647
Available from the Weather Bureau, Private Bag X097, Pretoria 0001.

A GUIDE TO THE USE OF SEPTIC TANK SYSTEMS IN SOUTH AFRICA

Revised by RJLC Drews

This publication, which was written by WM Malan and first published in 1964, and has continued to be popular over the years, has been updated and metricated.

The guide discusses the basic scientific principles underlying the design of septic tank systems and the factors to ensure the most successful functioning of the tank and the disposal of the effluent. Health aspects are considered as well as the effects of factors such as synthetic detergents, disinfectants, grease traps and the diets of different ethnic groups on the design and operation of the system.

Design criteria are suggested and useful data given on the volume of sewage to be expected, the best location for the tank and the capacities suitable for different communities, provision for the storage of sludge, ventilation, and the materials suitable for construction.

A soil percolation system designed in terms of soil type as indicated by a percolation test or visual observation and the possibility of applying the principle of evapotranspiration to soils relatively impervious to water as well as to areas with a high water table, are described.

1986
Price: R15,00 + G.S.T.
ISBN 0 7988 3416 1
Available on prepayment from the National Institute for Water Research, Council for Scientific and Industrial Research, PO Box 395, Pretoria 0001.

WATERBORNE DISEASES IN THE UNITED STATES

edited by Gunther F Craun

This publication considers diseases which occur by ingestion, bathing or wading, and inhalation. Chapters include epidemiologic procedures for investigation of waterborne disease outbreaks, methods to identify waterborne pathogens and indicator organisms, and barriers to the transmission of waterborne disease.

1986 304 pages
Price: US dollars 109,50
Available from CRC Press Inc., 2000 Corporate Blvd., NW, Boca Raton, FL 33431, USA.

PIPE PROTECTION

A review of current practice

by R Galka and APJ Yates

2nd Edition

1986
Price; USA dollars 75
ISBN 0 906085 94 2
Available from BHRA, the Fluid Engineering Centre, Cranfield Bedford, MK 43 OAJ, UK.

ANAEROBIC DIGESTION

A three day symposium on anaerobic digestion will be held at the University of the Orange Free State in Bloemfontein from 22 to 24 September 1986. Papers and exhibits are invited.

Enquiries: Mr Francois Marais, Non-formal Education, PO Box 4345, Bloemfontein 9300, Telephone: (051) 70661 × 425.

WATER MANAGEMENT

An international symposium on water: data processing and decision making will be held from 1 to 3 October 1986 in Montpellier, France.

Enquiries: Société Internationale de Congrès et Services, 337 rue de la Combe Caude, 34100 Montpellier, France.

GROUNDWATER MODELLING

The second course in the International Groundwater Modelling Centre's modelling programme will be held at Delft, the Netherlands, from 3 to 7 November 1986. The subject will be "Applied modelling of Groundwater pollution" and the course will include hands- on computer sessions using (micro-) computers.

Enquiries: Gerrit Tousma, Director, IGWMC, PO Box 285, 2600 AG Delft. (Tel.: (015) 569330 × 2110) or Wim Spaans, Course leader, IHE, PO Box 3015, 2601 DA Delft.

WATER SUPPLY

The 16th international water supply congress and exhibition will be held from 3 to 7 November 1986 in Rome, Italy.

Enquiries: Secretary General, IWSA/AIDE, 1 Queen Anne's Gate, London SWIH 9 BT.

WASTEWATER TREATMENT

The 9th Symposium on wastewater treatment will be held in Montréal, Québec, Canada, from 11 to 12 November 1986. Principal themes will be: Fundamental and applied research, Operation of treatment plants and Environmental Effects.

Enquiries: Mr Michel Gloutier, Technology Transfer and Training Division, Environmental Protection Service, Environment Canada, Ottawa, Ontario, Canada KIAIC8.

WEATHER STATIONS

A symposium on automatic weather stations and data logging systems will be held in Pretoria from 11 to 12 November 1986.

Enquiries: Symposium Secretariat S409, CSIR, PO Box 395, Pretoria 0001.

Telephonic enquiries:
Mr KE Estié (SAWB) (012) 61-2491/2; Dr G Held (CSIR) (012) 86-9211 × 3464/5; Mr JF Erasmus (SIRI) (012) 28-4048 × 336.

WATER SUPPLY

A conference on Resources of Southern Africa II will be held at the College of Education, Johannesburg, from 12 to 14 November 1986.

Enquiries: Symposium Secretariat S 400, CSIR, PO Box 395, Pretoria 0001, Tel: (012) 86-9211 × 2286.

CLIMATE RESEARCH

A conference on the mechanisms of international and longer-term climate variations will be held in Melbourne, Australia, from 8 to 12 December 1986. The conference has been timed to follow the Second International Conference on Southern Hemisphere Meteorology, to be held from 1 to 5 December 1986 in Wellington, New Zealand.

Enquiries: The organizing Committee Chairman, Dr Michael J Coughlan, Bureau of Meteorology, PO Box 1289K, Melbourne, Victoria, 3001, Australia.

CISTERN SYSTEMS

The third international conference on rain water cistern systems will be held in Khon Kaen, Thailand, from 14 to 16 January 1987.

Enquiries: Secretary Technical Committee, Third International Conference on Rain Water Cistern Systems, Faculty of Engineering, Khon Kaen University, Khon Kaen (40002), Thailand.

POLLUTANTS

An international conference on the vulnerability of soil and groundwater to pollutants will be held in Noordwijk aan Zee, the Netherlands, from 30 March to 3 April 1987. Papers are invited.

Enquiries: VSGP '87, c/o KIVI, PO Box 30424, 2500 GK, The Hague, the Netherlands. Telephone: (0) 70-919900.

HYDROLOGY

An international symposium on hydrology in perspective: lessons from the past, prospects for the future, will be held in Rome, Italy, from 6 to 10 April, 1987.

Enquiries: GIBA s.a.s. Studio Congressi, Via Marco Besso 40, 00191 Roma.

STABILIZATION PONDS

A conference on recent research on wastewater treatment in waste stabilization ponds will be held in Lisbon, Portugal, from 22 to 25 June 1987. Papers invited.

Enquiries: Professor DD Mara, WSP-Lisbon 1987, Department of Civil Engineering, University of Leeds, LS29JT, England.

WATER QUALITY

The first IAWPRC international symposium and exhibition on systems analysis in water quality management will be held in London, UK, from 30 June to 2 July 1987.

Enquiries: Dr MB Beck, Watermatex 87, IAWPRC, 1 Queen Anne's Gate, London, SWIH9BT, England.

FRESHWATER ECOSYSTEMS

An international conference on the biomanipulation of natural and artificial freshwater ecosystems will be held at Lake Kinneret, Tiberias, Israel, from 2 to 7 August 1987.

Enquiries: The Organising Committee, International Conference on Freshwater Ecosystems, PO Box 3190, Tel Aviv 61031, Israel.

IUGG 1987

The 19th general assembly of the International union of Geodesy and Geophysics will be held at the University of British Columbia, Vancouver, Canada, on 9 to 22 August 1987.

Enquiries: Conference Secretariat, c/o Venue West, 801-750 Jervis St., Vancouver, B.C. Canada V6E2A9.

HYDROLOGICAL SCIENCES

A symposium combining the Biennial Symposium of the Ground Water Division of the Geological Society of Southern Africa and the Third National Hydrological Symposium of

the South African National Committee for the International Association of Hydrological Sciences (SANCIAHS) will be held on 6 to 9 September 1987 at Rhodes University in Grahamstown.
Enquiries: Organising Committee, Hydrological Sciences Symposium, Department of Geography, Rhodes University, PO Box 94, Grahamstown, 6140.

OZONE

The 8th ozone world congress will be held from 15 to 18 September 1987 in Zurich, Switzerland, Papers and posters invited.
Enquiries: International Ozone Association, Swiss Committee, c/o Wasserversorgung Zürich, Hardhof 9, Postfach, CH — 8023 Zürich. Telephone: 01/435-2111, Telex: 822060 wvzch.

PHOSPHATE REMOVAL

An international specialised conference on biological phosphate removal from wastewaters will be held in Rome, Italy, from 5 to 7 October 1987.
Enquiries: Dr R Ramadori, IAWPRC International Specialised Conference, IRSA-CNR, Via Reno 1, 00198 Rome, Italy.

OFF-FLAVOURS

The second international symposium on off-flavours in the aquatic environment will be held in Kagoshima, Japan, from 12 to 16 October 1987. Papers are invited.
Enquiries: Professor T Motohiro, Faculty of Fisheries, Kagoshima University, 4-50-20, Shimoarata, Kagoshima 890, Japan.

NITROGEN POLLUTION

A specialised conference on nitrogen pollution of water will be held in Brussels, Belgium, from 24 to 28 November 1987. The aim of the conference is to up-date all present knowledge related to nitrogen and water of all kinds, including drinking water, waste water, agricultural water, lake and river water, industrial process water, etc. Papers are invited.
Enquiries: Dr WJ Masschelein, Laboratories C.I.B.E., 764 Chaussee de Waterloo, B-1180 Bruxelles, Belgium.

JUBILEE HYDROLOGY SYMPOSIUM

Theme: ''Fifty years of mountain catchment research in South Africa''.
Venue: Stellenbosch
Date: 11-13 November 1987

By 1987 it will be fifty years since the formal commencement at Jonkershoek Forestry Research Centre of research into the influence of plantation forests on streamflow. This marked the beginning of a programme that has contributed substantially to an understanding of vegetation and water supplies in South Africa, as well as making a mark internationally. It also grew to encompass many ecological aspects of the matter, leading to substantial improvements in our understanding of the fynbos and grassland ecosystems in mountain catchments.

This anniversary will be marked by holding a two-day symposium, followed by an open day, on the topic ''Fifty years of mountain catchment research in South Africa''.

Papers will be presented on invitation by overseas and local specialists on a range of subjects including:

- ☐ Water resource and land use planning.
- ☐ Environmental and ecological constraints in catchment management.
- ☐ Water use by crops.
- ☐ Evapotranspiration from forests.
- ☐ Afforestation and water supplies.
- ☐ Multiple use management in mountain catchments.
- ☐ Catchment management in developing communities.

Poster sessions will accommodate voluntary contributions and demonstrations of equipment.

Written enquiries should be forwarded to the Department of Environment Affairs, PO Box 727, Pretoria 0001.

Mr DL Owen Telephone: (012) 28-7120
Mr DP Bands Telephone: (02231) 7-2805

INSTITUTE ON WATER POLLUTION CONTROL: MONTHLY MEETINGS AND SYMPOSIUM PROGRAMME FOR REST OF 1986

18 September 1986

- ☐ ''The fate of phosphate in the Vaal catchment Area'' — Mr R Haynes — Rand Water Board
- ☐ ''Suggestions for operator training in the RSA based on British practice'' — Mr N Lewis — Directorate of Pollution Control, Department of Water Affairs

31 October 1986

Institute on Water Pollution Control/National Institute for Water Research/Water Research Commission/Department of Water Affairs — Symposium — ''Water for the Future''

20 November 1986

- ☐ ''Herwinning van kalk as koagulant'' — Mr J Geldenhuis — Rand Water Board
- ☐ ''Epidemiologiese studies oor watergedraagde siektes in die RSA'' — Dr HGV Küstner — Departement van Nasionale Gesondheid en Bevolkingsontwikkeling.

For more information contact: Dr Herman Wiechers at the WRC. Telephone: (012) 28-5461.

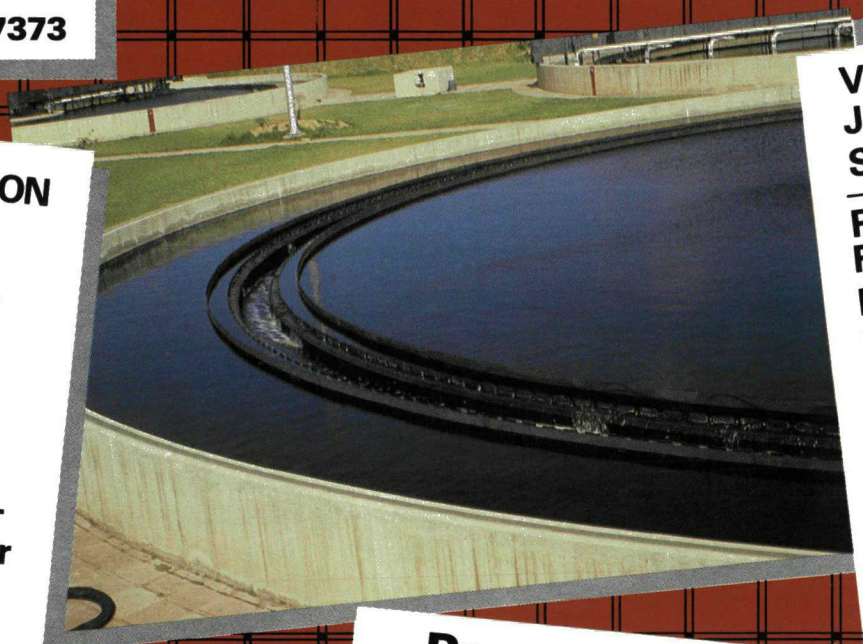
30 October 1986

Technology Transfer Symposium

Towards a better understanding of biological phosphate removal

ENQUIRIES

Mrs L Lötter
City Health Dept.
P.O. Box 1477
Johannesburg
Tel: (011) 728-7373



REGISTRATION CARD

Please complete and return the registration card in the Bulletin together with your payment.

VENUE
Johannesburg Sun hotel

REGISTRATION FEE

R30. Includes luncheon and tea and all documentation.
Cheques payable to the City Treasurer *before* 30 September 1986.

Programme

08h00 – 09h00:	Registration.
09h00 – 09h15:	Welcome: Dr J Mortimer Director Technical Services.
	Session 1: Background.
	Chairman: Dr H N S Wiechers.
09h15 – 09h30:	Introduction: Dr H N S Wiechers.
09h30 – 09h55:	Enhanced phosphate removal: Experimental objectives. Mr A R Pitman.
09h55 – 10h15:	TEA
	Session 2: Full-scale Experimentation.
	Chairman: Mr J Goodman.
10h15 – 10h55:	Investigations into filamentous organisms causing scum formation and bulking in nutrient removal activated sludge systems. Mrs L N Melmed.
10h55 – 11h35	Experiments to improve biological phosphate removal in the Johannesburg Northern Works Plant. Mr H A Nicholls.
11h35 – 12h05:	Determination of fatty acids and readily biodegradable COD. Mrs L H Lötter.
12h05 – 12h45:	The use of continuous on-line monitors in plant control. Mr H A Nicholls.
12h45 – 14h15:	LUNCH
	Session 3: Fundamental studies.
	Chairman: Mr G Keay.
14h15 – 14h55:	The importance of various bacterial species in nutrient removal activated sludge. Miss M Murphy.
14h55 – 15h35:	The usefulness of certain biochemical parameters in assessing nutrient removal plant performance. Mrs L H Lötter.
15h35 – 16h00:	TEA
16h00 – 16h15:	Summary: Mr A R Pitman.
16h15 – 16h30:	Closure: Dr Hilliard S. Hurwitz, Medical Officer of Health.
17h00	Presentation of the contract report to the Chairman of the Water Research Commission.
	COCKTAIL PARTY.

Cocktail Party

Delegates are invited to a cocktail party after the Symposium. During this function the Final Contract Report will be presented to the Water Research Commission.

Please indicate on the registration card whether you wish to attend this function or not.

KRY WATERINLIGTING GRATIS EN GOU KONTAK WATERLIT

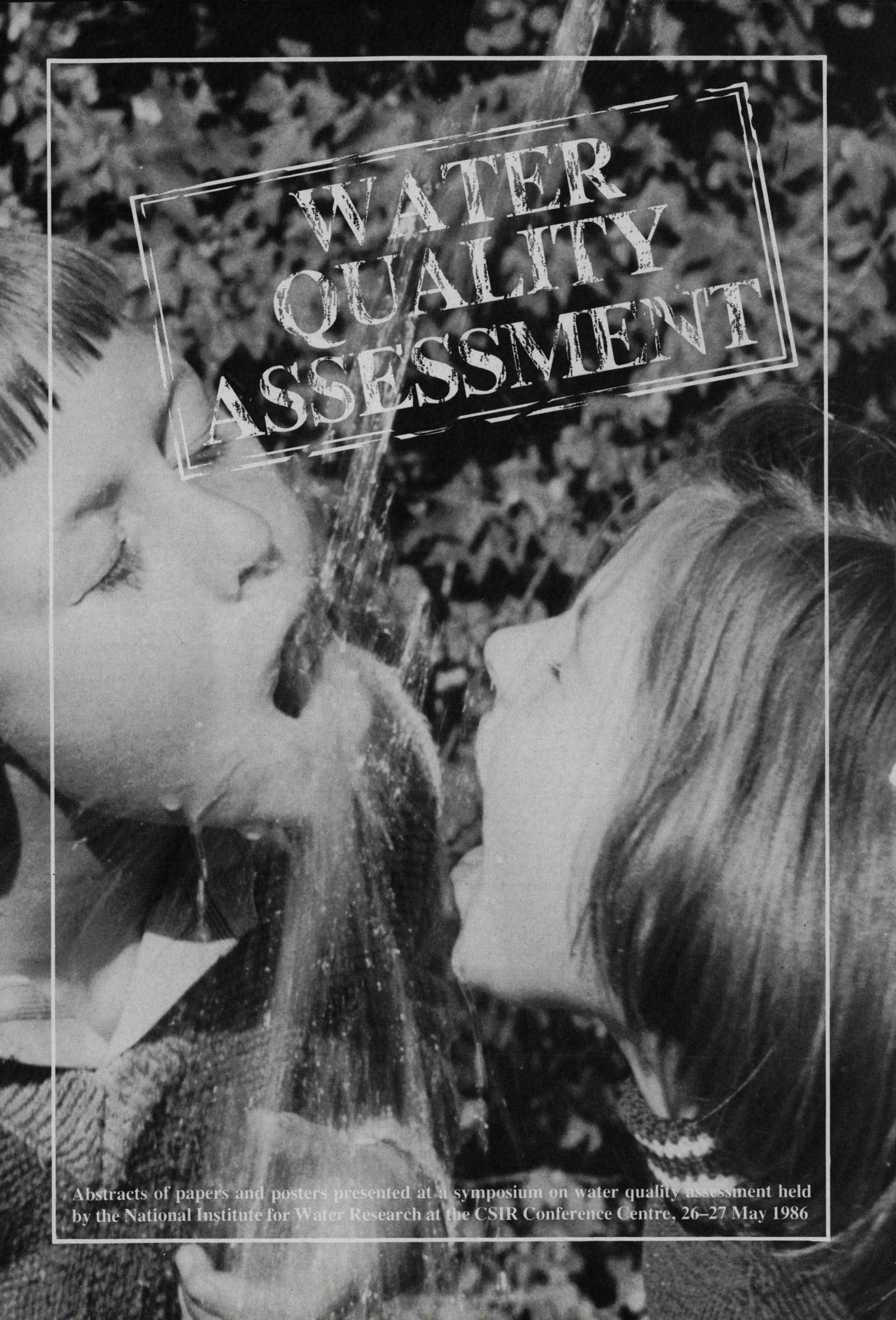
Waterlit is 'n gerekenariseerde databasis met wêreldwye inligting oor water.

Meer as 105 000 verwysings na artikels, verslae, boeke, patente, tesisse en konferensie-mededelings oor water is tans tot jou beskikking in die Waterlit-rekenaar.

En die aantal verwysings styg steeds.
'n Span indekseerders fynkam gereeld sowat 600 wetenskaplike en tegniese tydskrifte en voer elke maand oor 'n duisend nuwe verwysings na inligtingsbronne oor water in die databasis in.

Waterlit hou jou op die hoogte.
Vir meer besonderhede skakel die Suid-Afrikaanse Inligtingsentrum Vir Water by (012) 86-9211 X 3083 of 2048.

WATERLIT
Inligting van die eerste water.



WATER QUALITY ASSESSMENT

Abstracts of papers and posters presented at a symposium on water quality assessment held by the National Institute for Water Research at the CSIR Conference Centre, 26–27 May 1986

DISCUSSING A COMPLEX AND DIVERSE PROBLEM*

WATER QUALITY

The motto *No Life Without Water* does not only refer to the availability of water, but also to the quality of water, because poor quality water can be as detrimental as no water at all (e.g. a ship-wrecked person in a life raft on an ocean of seawater!).

The importance of water quality with regard to human health is illustrated by the following examples:

- ☐ According to the World Health Organization, some 20 million people per year, or about 50 000 per day, die from diseases caused by poor quality water and insanitary conditions.
- ☐ Even in a developed country such as the USA, about 38 outbreaks of water-borne diseases with some 10 000 cases are reported each year. During the past 20 years, 90 water-borne outbreaks with 24 000 cases of *Giardia gastroenteritis* alone have been recorded.
- ☐ The health implications of chemical compounds in water are difficult to assess because many of them have long-term effects with the result that the source cannot easily be identified. However, it is known that some 70 000 different man-made chemical compounds are today in common use, and it has been estimated that these chemicals, most of which inevitably find their way into water sources and supplies, may be responsible for 50 to 90 per cent of human cancer cases.

Apart from the remarkable impact on a wide variety of health and aesthetic aspects of life, quality of water also has far-reaching economic implications. For example, the deteriorating quality of water in the Vaal River system, due to pollution, involves increasing levels of total dissolved solids which are now approaching levels which may require desalination of the water at a cost of as much as R140 million per year. Of probably even greater concern are the increasing levels of organic compounds, the removal of which will increase the cost of domestic water supplies derived from the Vaal River system by an estimated 40 per cent. Likewise, the deteriorating quality of the Hartbeespoort Dam has implications to the value of millions of Rands on the utilisation of the water for agricultural, domestic and recreational purposes.

Although information on many aspects of the impact of water quality in South Africa is limited, particularly with regard to water-borne diseases, there is no reason to believe that the country is an exception to fundamental rules recognized in the rest of the world. To the contrary, the health risks and economic implications associated with water quality are probably even more important than in many other parts of the world because the limited supplies have to be fully utilised and extensively reused to meet the escalating demands of rapid growth in population, industry and agriculture.

As a result of its fundamental importance, water quality assessment forms an integral component of the water industry, and is a major factor in the cost of water supplies. In South Africa, the requirements of technology for water quality assessment are particularly complex and diverse. The reason is that the technology has to meet the requirements of supplying water to consumers who range from Third World rural communities to intensive agriculture, modern industries and densely populated cities, while the water sources are limited and often heavily polluted. The technology for water quality assessment also has to cater for research aimed at improvement of the efficiency and cost of water treatment and supply systems, the fluctuating importance of various diseases, new risks associated with issues such as urbanisation, and new water quality requirements.

This was the background to the Symposium. It was the first of its kind in South Africa which specifically addressed the fascinating diversity and exciting challenges of water quality assessment, and primarily had the following objectives:

- ☐ To review and discuss presently available technology for water quality assessment.
- ☐ To identify future technology requirements.
- ☐ To establish mechanisms of technology transfer.

The programme consisted of introductory papers dealing with needs for water quality assessment and various aspects of water quality guidelines in South Africa, followed by technical papers, a visit to water quality laboratories at the NIWR, and a final open discussion session.

*Welcome address delivered by Dr J B Clark, Deputy President of the CSIR at the opening of the symposium on water quality assessment.

A REVIEW OF WATER QUALITY REQUIREMENTS IN SOUTH AFRICA

WA Lombard

W A Lombard

South African Bureau of Standards,
Private Bag X191,
Pretoria 0001

Prior to the promulgation of the Water Act in 1956, virtually the only quality requirements for water supplies or industrial discharges in South Africa were two specifications published by the South African Bureau of Standards (SABS). Nevertheless, these had no legal backing and were only issued as general guidelines. However, the introduction of the Water Act empowered the Minister of Water Affairs to lay down quality requirements for industrial effluents, after consultation with the SABS. The Act also placed particular emphasis on the re-use aspect of water used for industrial purposes.

In order to give effect to these requirements in the best possible way, a careful study was made of the then prevailing situation, as well as of control facilities available. It was concluded that a general specification for municipal sewage works discharges should be compiled to cover the majority of discharges occuring, and that the remainder should be dealt with by means of exemption permits required.

The original General Standard has been amended from time to time down the years, but the basic concept still holds. Increasing attention is being paid to limiting increases in total mineral content of effluents, however, as well as to the possible presence of toxic metals. The analyses called for on samples taken by the Department of Water Affairs illustrate this shift in emphasis.

In the field of water for domestic supplies, increasing attention is being given to the occurrence of micro-pollutants. Controversial views exist on the need to remove all such compounds, and on the financial implications of such action. There is a need to take care, when using analytical methods enabling determinations to be made in the parts per billion range, that the findings are used in a realistic context. This is of particular importance in South Africa with its mixture of First World and Third World conditions.

TOEPASSING VAN DRINKWATERGEHALTE-NORME DEUR GESONDHEIDSOWERHEDE

FS Vivier

F S Vivier

Departement van Nasionale Gesondheid en Bevolkingsontwikkeling,
Privaatsak X63,
Pretoria 0001

Oor die afgelope dekade of twee het verskeie stelle drinkwatergehaltenorme en -standaarde wêreldwyd die lig gesien. Ten spyte van die steeds toenemende kennis oor die invloed van kontaminante in water op die mens se gesondheid, bly dit steeds onmoontlik om absolute maksimum veilige konsentrasiegrense daarvoor te bepaal. Gevolglik duur die tendens voort om geïdealiseerde norme en standaarde met groot veiligheidsfaktore te gebruik wat ook geredelik deur ontwikkelde lande met voldoende beskikbare tegnologie en geldelike vermoëns gehandhaaf kan word.

Suid-Afrika is 'n ontwikkelende land waar die ontwikkelingspeil van verskillende plekke en gemeenskappe van hoogsgesofistikeerd tot ongesofistikeerd wissel. Verder is die waterbronne beperk en word groot wisselinge in gehalte aangetref. Water wat dus in Suid-Afrika vir huishoudelike doeleindes voorsien of gebruik word kan aansienlik in gehalte van plek to plek verskil afhangende van die invloed van 'n wye reeks aspekte soos die geohidrologiese eienskappe van die omgewing; die mate van waterbesoedeling en -hergebruik; persoonlike gewoontes, voorkeure en lewenstyl; groepe en gemeenskappe se tegnologiese en geldelike vermoëns; die vlak van bestaande plaaslike infrastrukture; en die bewustheid van die potensiële gesondheidsgevare van water in die algemeen.

Gedurende 1979 is die taak om 'n omvattende stel watergehaltenorme op te stel, vir

gebruik onder Suid-Afrikaanse omstandighede, as deel van 'n gesamentlike navorsingsprojek van die Departement en die Nasionale Instituut vir Waternavorsing, onderneem. Voortspruitend hieruit is 'n Navorsingsverslag No. 628 *Voorgestelde Estetiese/Fisiese en Anorganiese Drinkwaterkriteria vir die RSA* onlangs deur die NIWN gepubliseer. Hierdie aanbevelings asook dié ten opsigte van die mikrobiologiese norme is in beginsel deur die Departement aanvaar en sal mettertyd in 'n toepaslike formaat as riglyn beskikbaar gestel word.

Hierdie riglyne vir drinkwatergehalte is uniek omdat dit, afgesien van die bekende aanbevole grens en maksimum toelaatbare grens of hul ekwivalente, ook 'n derde grens wat 'n geringe risiko inhou, aandui. Die doel hiervan is om die klem op die deurlopende toenemende estetiese of gesondheidsrisiko te plaas wanneer 'n bepaalde kontaminant of bestanddeel in konsentrasie sou toeneem.

Die drie grense verdeel dus die totale konsentrasiegebied waarin 'n bestanddeel moontlik in drinkwater kan voorkom in vier toenemende konsentrasiegebiede, naamlik Geen Risikogebied, Onbeduidende Risikogebied, Lae Risikogebied en Hoë Risikogebied.

Alhoewel dit die oogmerk is dat gesondheidsowerhede hierdie norme in die toekoms sal gebruik by die beoordeling van die gehalte van huishoudelike water wat deur die plaaslike besture of ander waterleweransiers aan verbruikers beskikbaar gestel word, kan dit ook leiding gee by die risikobeoordeling van drinkwater in die algemeen.

INFECTIOUS DISEASE AND WATER

J W Moodie

Department of Medical Microbiology,
Medical School,
University of Cape Town,
Observatory 7925

The transmission of disease by water implies that water is merely the inert vehicle capable of sustaining a disease-inducing agent but that in itself it is not pathogenic. This concept may well be relevant to disease caused by infectious agents and disregards the presence of non-infectious soluates as significant health hazards. History is less dramatically populated with accounts of disease resulting from non-infectious agents and this may be partially due to the realization only in recent times of the concept of carcinogenesis or even mutagenesis enhanced by modern practises of toxic waste disposal and water treatment. Nevertheless, important as these concepts are, the role of infectious agents in water remains of prime importance to health authorities as pollution of water supplies can result in immediate and disastrous epidemics.

Perhaps the episode of the Broad street pump and the pioneering investigations of John Snow has retained its impact to this day as a classical model, but while detail of the methodology used to determine the casual relationship is obligatory for young epidemiological intelligence officers, many have difficulty recalling the actual pathogen involved in the outbreak.

Most of the recorded epidemics of water-borne disease relate to bacterial pathogens and typhoid and cholera retain their importance in areas of the world where drinking water supplies are liable to faecal contamination. Similarly, the large tracts of Africa where bilharzia is endemic, pose a special problem and the infestation of the indigenous populations by the parasite detracts significantly from the general health of the community and may contribute to the development of an altered immune response to other disease such as hepatitis.

Less clear is the impact of enteric viruses in drinking water as a major health hazard. Certainly there are accounts of large-scale epidemics of viral disease from the pollution of water supplies where a virus such as non-A and non-B hepatitis is introduced and the population is susceptible as occurred in Delhi. As faecal contamination of water most commonly occurs where standards of personal hygiene are low, most of the population exposed has already acquired immunity to common enterovirus infections such as poliomyelitis and hepatitis. Not surprisingly, accounts of episodic viral illness from water are from developed countries when a high proportion of those exposed to contaminated water are susceptible. This applies to the enteroviruses and rotaviruses as well as other largely unclassified small round viruses such as Norwalk agent.

COLIFORM BACTERIA AS WATER QUALITY INDICATORS

WOK Grabow

W O K Grabow

Water Quality Division,
National Institute for Water Research,
CSIR,
P.O. Box 395,
Pretoria 0001

Despite shortcomings, coliform bacteria are the most commonly used indicators of the microbiological quality of water, and since their introduction some 90 years ago, they have established a remarkable record of success. Through the history of their world-wide application, the nomenclature and methods of detection of these bacteria have been frequently revised. This is reflected by the outcome of a country-wide survey carried out in 1978 in southern Africa which revealed that the 59 participating laboratories used a wide variety of methods which do not yield comparable results. In order to standardize technology and the interpretation of results, appropriate techniques were selected and recommended for uniform application. These recommendations are incorporated in the 1984 issue of the South African Bureau of Standards's *Specification for Water for Domestic Supplies,* and in the latest water quality guidelines of the Department of National Health and Population Development. The recommendations, which are in line with principles currently accepted internationally, specify that coliform bacteria should be used in the following three categories for water quality assessement:

- **Total coliforms.** Bacteria which form golden-green colonies with a metallic sheen on membrane filters incubated on M-Endo agar for 24 h at 35 °C. The test comprises a wide variety of organisms and serves an an indicator of the general hygienic quality of water. It is primarily used for testing drinking water supplies.
- **Faecal coliforms.** Bacteria which form blue colonies on membrane filters incubated on M-FC agar for 24 h at 44,5 °C. The test comprises a restricted group of bacteria closely associated with faecal pollution. It is fairly specific for sewage pollution and mainly used for assessment of the quality of wastewater effluents, rivers, dams, seawater and raw sources of drinking water supplies.
- **Escherichia coli.** These bacteria are indole positive faecal coliforms. The test comprises a single species which is specific for faecal pollution. The test is primarily used for confirmation of faecal pollution in drinking water supplies.

Although the above coliform tests fulfil a valuable purpose in water quality assessment, research on possibilities of overcoming some of their shortcomings is in progress. For instance, methods which would yield similar information in a shorter period, perhaps even in the form of a continuous automatic monitoring system, would be most valuable in the modern water industry. Other questions which remain to be resolved include the health and water quality significance of stressed coliform bacteria which are not detected by the above methods.

ASSESSMENT OF THE VIROLOGICAL QUALITY OF WATER

K E U Brodisch, W O K Grabow, B W Bateman and P Coubrough

Water Quality Division,
National Institute for Water Research,
CSIR,
P.O. Box 395,
Pretoria 0001

KEU Brodisch

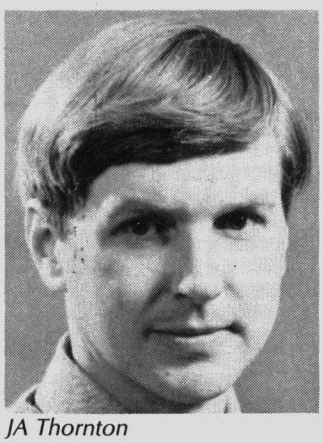
BW Bateman

The potential health implications of water-borne viral diseases are illustrated by an outbreak of viral hepatitis with some 40 000 cases in 1955 in Delhi, India, due to accidental sewage pollution of the drinking water source. As more viruses are discovered and their epidemiology is unravelled, evidence accumulates that water may play a more important role in the transmission of viral diseases than previously thought. Indications are that viruses associated with gastroenteritis such as rota, adeno and norwalk, as well as the epidemic non-A, non-B hepatitis virus and others which remain to be fully characterized may be frequently transmitted by water.

In our laboratory, assessment of the virological quality of water is carried out as follows: In the case of drinking water, viruses are recovered from 10 ℓ samples by means of flat membrane ultrafiltration, which has the highest efficiency of recovery of methods presently available. Alternatively, an adsorption-elution method using an in-line positively charged cartridge filter is used to recover viruses from volumes of 100 ℓ or more. In conventional analyses the recovered viruses are inoculated into primary vervet kidney (PVK) cell cultures for detection by cytopathogenic effects, using large culture flasks for presence/absence tests or tube dilution assays for titrations. PVK cultures are more suceptible to human enteric viruses than the cell lines generally used for the virological analysis of water. Research currently in progress indicates that the PLC/PRF/5 human liver cell line is even more sensitive, and these cells may be used in future.

Viruses detected by the above method are not of major concern in water hygiene, which implies that they primarily serve as indicators of virological quality. Research is, therefore, in progress to detect more important viruses such as hepatitis and gastroenteritus viruses. Hepatitis A and rotaviruses can already be detected by enzyme-linked immunosorbent assays (ELISA), but these are not sensitive enough for testing drinking water. Since presently used virological methods have the additional shortcomings of being slow and expensive, reliable indicator systems have been designed for assessment of the virological safety of water. Coliphages proved particularly useful indicators, and simple, inexpensive techniques which yield results within 16 h, have been developed for their detection in routine water quality analysis.

A LIMNOLOGICAL VIEW OF WATER QUALITY CRITERIA



JA Thornton

J A Thornton

Limnology Division,
National Institute for Water Research,
CSIR,
P.O. Box 395,
Pretoria 0001

Limnology is the science of the study of the physics, chemistry and biology of freshwaters, especially lakes. As such, it is interested in the status of water bodies relative to a natural or undisturbed state. Traditionally, this concept of trophic status, which most limnologists consider to be synonymous with water quality, has considered both biological criteria and chemical criteria as the foundation stones of any quality assessment. Waters enriched with the plant nutrients nitrogen and phosphorus are commonly rich in algae (as measured by the plant pigment, chlorophyll *a*) but poor in species diversity, and are called eutrophic. Natural waters, with low algal populations, good diversity and low nutrient concentrations are called oligotrophic and are of good quality. However, these criteria differ markedly from the dissolved solids, organics and bacteria/viruses commonly used as criteria by other disciplines. Hence limnologists rarely contribute meaningfully to South African water authorities. This paper presents a summary of comparative criteria used by limnologists and other disciplines in the endeavour to allow both groups to interact more fruitfully, and together work to optimise the use of South Africa's water recources. In particular, this paper examines the output of a number of commonly used limnological models in relation to the information needs of water works operators, water treatment plant operators and water-related decision-makers. Reference is made to Hartbeespoort Dam and other southern African lakes to provide actual examples of the concurrent use of limnological and other water quality criteria, and to highlight the use of integrative lake classification schemes such as the GDR Technical Standards for the classification of lakes.

FLOW-INJECTION DETERMINATION OF INORGANIC SUBSTANCES IN WATER

JF van Staden

J F van Staden

Department of Chemistry,
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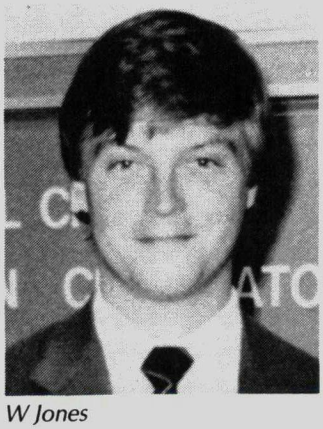
Water is used for many purposes in daily life of which drinking water forms a major part. The diversity and complex nature of inorganic substances present in water originates mainly from agricultural, industrial and mining sources. The contribution of these sources makes a unified approach in some areas of water analysis almost impossible. However, a large number of water samples are submitted to routine water laboratories every day and the determination of inorganic substances is of importance in the examination and effective control of these substances in natural water and industrial effluents. To supply needed data in time and effectively, rapid and reliable methods are needed for the continuous determination of these components in water.

The concept of flow-injection analysis is one technique which may satisfy the abovementioned prerequisites. A critical review of the present status of flow-injection analysis of inorganic substances in water is given referring to methods described, manifolds used, techniques available and detectors interfaced. Special attention is given to the question: Is it possible to use these methods in routine laboratories or not?

WATER ANALYSIS USING ION CHROMATOGRAPHY



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Ion chromatography is becoming increasingly important in water analysis in that multiple ions can be analysed at one time. Utilizing various resin based ion exchange columns and in most cases direct conductivity detection allows for not only anions and cations but also organic acids and transition metals. The focus of this paper is on water analysis from several sources, e.g. rain, rivers and industrial influent and effluent, with an introduction to recent developments in coupled ion chromatography.

The elimination of post column chemistries prior to the conductivity detector allows for a greater variety of eluents that can be used to vary selectivity and sensitivity. An example of this is the analysis of free cyanide, sulfide, chloride and carbonate in waste water using a hydroxide eluent, an anion exchange column and a conductivity detector. Changing over to a borate based eluent with the same column and detector allows for chloride, nitrate and sulfate in acid rain. Coupled ion chromatography utilizing two detectors, two columns and an automated switching valve allow for more ionic information to be obtained in a single injection. One particular mode that is shown is the simultaneous determination of anions and cations in tap water.

A LABORATORY COMPUTER SYSTEM FOR PROCESSING ANALYTICAL DATA

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The Johannesburg Health Department has a Laboratory Branch which provides a wide range of services to the whole Municipality and the community. The bulk of the routine functions consists of the chemical and microbiological analysis of water, wastewater and foodstuffs. The Laboratory not only issues 'immediate' reports on analyses undertaken but also assists in the evaluation of data, particularly over the long-term.

A computer system was installed at the Central Laboratory in 1977. Since that time, it has been expanded and similar computers have been installed at two other laboratories within the Branch.

Hardware for the main computer consists of:-

256K byte 16-bit minicomputer
20 M byte disc storage
Eight track magnetic tape
Dot matrix printer
Daisy wheel printer
Plotter
Cassette deck
Analogue to digital interfaces for instruments
Digital interfaces for instruments
Visual display units.

Instruments linked directly to the computer are:- Autoanalysers, an atomic absorption spectrophotometer and a 'Milkoscan' milk analyser.

At the time of installation of the computer, vendor software for laboratory management was in its infancy and programs had to be specially prepared. Almost all of the software has been written by laboratory staff. Programs have been designed to cater for the specific requirements and sampling patterns of the various types of samples.

All data are retained indefinitely on disc or on magnetic tape. Programs enable data to be recalled and presented in tabular or graphical (including histograms) form. Statistical facilities include the screening for outliers, the calculation of confidence intervals of means and the plotting of trend lines.

Data received directly from instruments are controlled by the laboratory staff operating the instruments. The remaining work, including the printing of all reports, worksheets, etc., and the routine maintenance of the system, is performed by a part-time administrative assistant.

Back-ups are made regularly. A magnetic tape is run daily to duplicate data entered over the previous 24 hours. All archived data are kept either on two discs or on a disc and magnetic tape.

GC/MS IDENTIFICATION OF ORGANIC MICROPOLLUTANTS

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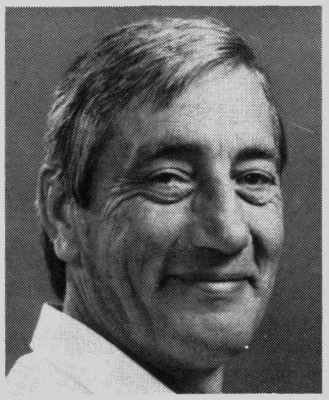


AJ Hassett

The identification of organic micropollutants in drinking and surface waters and the assessment of the possible health hazards they may constitute are two very closely related tasks. A pre-requisite to the evaluation of significant hazards due to low level background contamination or to specific contamination, often at high levels, is the identification and characterization of these micropollutants. This has become a major factor where short-term bioassays, such as the Ames tests, which indicate a potential genotoxic hazard, are being applied to water.

GC/MS techniques have developed remarkably over the past 20 years and have revolutionized qualitative analyses of water. These techniques are unfortunately limited to the 'volatile' fraction of organic compounds. The overall identification technique employed is the isolation and concentration of the micropollutants from an aqueous matrix, followed by the separation of each component in a complex mixture, the detection of these compounds and, finally, the structural identification.

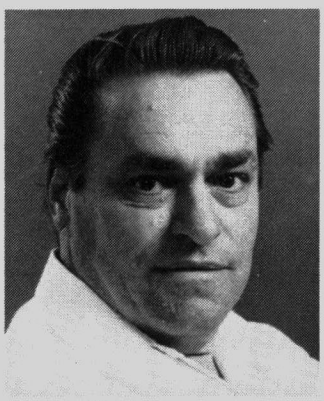
For the routine analysis of water samples, a liquid-liquid extraction isolation technique is employed, which allows the selective extraction of the neutral and phenolic compounds. Separation of the resulting complex extracts is accomplished by high resolution capillary column gas chromatography. Derivatization of the phenolic compounds permits the analysis of these and the neutral compounds on the same chromatographic column.

The mass spectrometer, used for the detection of these compounds, often detects large numbers of organic chemicals in drinking and surface waters. Depending on the degree of contamination, more than 10% of these compounds cannot be identified, even with the large reference mass spectra data banks which are available.

Most modern GC/MS systems provide not only electron impact ionization, but also chemical ionization spectra of the same peak. The added data obtained from the chemical ionization spectra greatly assists in the identification of 'unknowns'.

Recently developed MS ionization methods, the so-called soft ionization techniques, have the potential of providing mass spectra of the thermally unstable and non-volatile fraction of micropollutants, of which so little is known. A technique which may supply information about this unknown area is the method of HPLC/MS. This technique has great potential in the field of water analyses and water research.

AUTOMATED INSTRUMENTATION FOR THE CONTINUOUS MONITORING OF ORGANIC GROUP DETERMINANDS



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Mounting evidence exists that long-term exposure to low concentrations of certain organic chemicals in water can be an important factor in the development and manifestation of some chronic diseases. These organic materials enter the hydrological cycle from a variety of sources and there is, therefore, an obvious need for continuous vigilance, not only concerning their occurrence and concentration, but also to design processes to remove them. Because of its complexity, a complete characterization of the organic contents of water does not exist and most analytical techniques, i.e. GC-MS, HPLC, etc., can only account for approximately 10% of the total organic contents present. In addition, analysis is time-consuming, and by the time results become available the water has already been consumed.

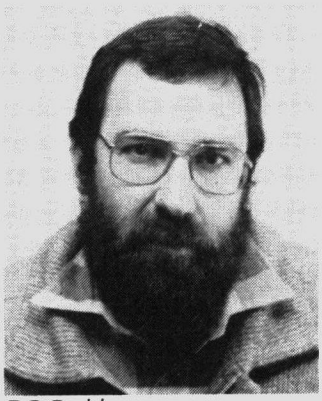
The term automation is a relatively new concept to the analytical chemist, but the revolution in the field of electronics has now made this concept fundamental to virtually every analytical procedure in the laboratory. Since no method existed for the direct on-line determination of the organic carbon content of water, the National Institute of Water Research, with the financial support of the Water Research Commission, developed a fully automated on-line multisampling channel total dissolved organic carbon (DOC) analyser.

The DOC autoanalyser utilizes ultraviolet peroxodisulphate oxidation of the organics in a water sample followed by infrared detection of the CO_2 liberated. All operations, including

data handling, are controlled by a microcomputer which can be tailor-programmed. Communication with the computer is via a keyboard and LC display. Results are obtained by print-outs as average concentrations of readings taken every six seconds over a period of 3 to 10 min, or as graphic displays. Single sample source print-outs are obtainable for any time intervals. Concentration range is 1 to 30 mg/ℓ with a repeatability of ±2% of full scale. For higher concentrations, a dilution step can be incorporated in the system. Alarms and print-outs warn of system faults, power failures and when preset concentration levels are exceeded. The market cost of this local product will be some 50% less than that of imported DOC analysers which are not on-line systems.

Similar development work is in progress for the determination of total chlorinated hydrocarbon compounds and ultraviolet absorption measurements.

STATISTICAL ANALYSIS OF WATER QUALITY DATA



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Statistical analysis of water quality data to yield information on which to base planning and management of water resources is a most crucial component of water quality monitoring. In most organizations only certain components of water quality monitoring, i.e. sampling, laboratory analyses and data storage, are emphasized and data analysis as well as the use of information gained from the analysis in planning and management are neglected.

There are many reasons for inadequate data analyses and action upon the information gained, but an important one is that water quality usually represents very complex systems. For example, the water quality in a natural stream at any particular moment is determined by (i) diurnal, seasonal and long-term events (i.e. wet and dry cycles); (ii) random events such as thunderstorms; and (iii) the influences of man, such as changing land use and the return of effluents to streams. Natural systems are not amenable to controlled experimentation and it is unlikely that any particular combination of events affecting water quality will ever be exactly repeated. Consequently, the analysis of data for natural systems, to yield useful information, is not a trivial exercise.

Scientists and engineers were traditionally schooled in statistical techniques known as confirmatory data analysis (i.e. applying the t-test to establish if two sample means differ statistically). However, it is now realized that confirmatory data analysis, although it has an important role to play, is insufficient for analyzing water quality data. Consequently, much attention is now being paid to exploratory data analysis with which data are explored for useful relationships and trends. Many techniques in exploratory data analysis are based on drawing graphs as aids to visual interpretation and many of them are robust (i.e. they are not restricted by severe assumptions). In this paper some examples of exploratory data analysis are used to illustrate their usefulness.

QUALITY CONTROL IN THE WATER ANALYSIS LABORATORY

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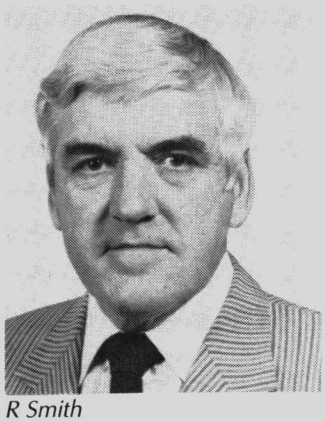


R Smith

The main function of a laboratory engaged in water and/or wastewater analysis is the provision of data which indicate the concentrations and characteristics of constituents in water samples submitted to that laboratory. As these data are often employed as the basis for important decisions concerning, for example, process control of water and wastewater treatment or the assessment of the value and progress of research investigations, it is essential that the water analysis laboratory has as one of its main objectives the production of analytical results which are accurate, precise, and adequate for the intended purpose. This objective can be largely accomplished by the application of cost effective, planned, and documented 'internal' and 'external' quality control systems. It has been established by some experts in this field that such activities should constitute between 10% and 20% of the analyst's time, with a substantial part of that time centred on preventive maintenance and the analysis of check and reference samples.

Among the 'internal' quality control procedures which can be applied, and which are described and discussed in this paper, are:

(1) Use of appropriate sample design, sample collection and sample preservation procedures.
(2) Use of only recognized standard methods of analysis.
(3) Regular calibration of apparatus.
(4) Application of a regular system of data verification, for example use of control charts and reference samples, 'balancing' of results.

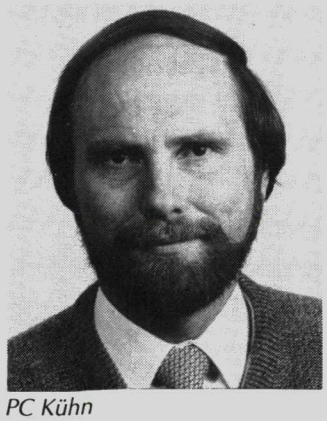
Laboratories can also supplement these 'internal' methods of quality control by applying various 'external' procedures, such as:

(1) Performance evaluation and method evaluation by participation in interlaboratory comparison studies.
(2) Participation in laboratory certification programmes.

These procedures are also described and discussed in this paper.

CONTINUOUS AUTOMATIC BIOLOGICAL SURVEILLANCE TECHNIQUES

WSG Morgan



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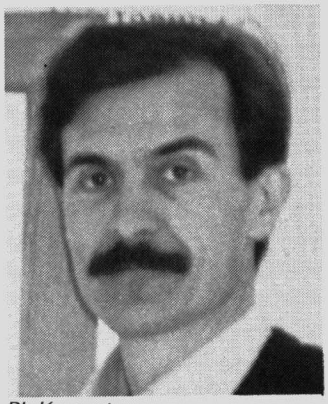
Automated biological surveillance systems, employing pre-mortal symptoms in fish as an indication of insidious toxic conditions, have been developed to prevent hazardous industrial discharges from deleteriously affecting freshwater ecosystems, thereby maintaining their biological integrity and assimilatory capacity. The parameters used to detect the occurrence in wastewaters of situations toxic to fish have been opercular movement, monitored by processing the signal which arises as a result of a change in potential between submersed stainless steel electrodes caused by the muscle action potentials arising from ventilatory movements, and locomotory activity, monitored by means of an ultrasonic Doppler shift technique.

Laboratory investigations have been conducted on the capability of such systems to detect acute, sublethal and chronic levels of water-borne toxicants; the effect of long-term exposure to very low toxicant concentrations on fish sensitivity; the effect of ambient temperature on the parameters employed and the adequacy of the statistics used to establish hazard detection levels.

Prototype surveillance systems utilized mechanical or electronic counters for data acquisition and employed a single set limit for toxicant detection. Such systems were found to be simple to implement and operate by non-technical personnel. However, this method of handling data does have its disadvantages in that slight but important changes in respiration

rate or activity may not be detected. The introduction of inexpensive microcomputers into the South African market has made it possible for modern systems to incorporate more sophisticated analyses. A surveillance system recently developed to assess the quality of domestic and industrial effluent discharge to the marine environment at Richards Bay includes a data acquisition and control module structured around a microcomputer using Basic language.

TRACE METAL DETERMINATION BY INDUCTIVELY COUPLED PLASMA OPTICAL EMISSION SPECTROMETRY (ICP)



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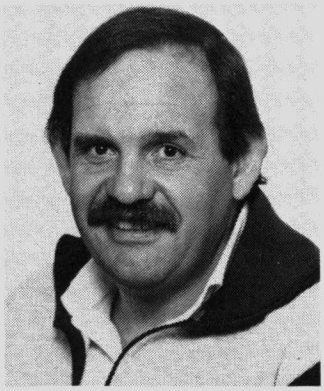
The analytical techniques traditionally employed for the determination of pollutant metals in water and related environmental samples is atomic absorption spectrometry (AAS). The essentially single element character of AAS, however, places a limitation on sample throughput, and the environmental researcher must often be satisfied with a data set with limited element coverage. The inductively coupled plasma optical emission spectrometry (ICP) technique, however, allows for the simultaneous determination of many metals on a single sample solution, where a multichannel spectrometer is used. The advantage of such simultaneous determination of analyte metals is firstly the increase in the element coverage of the data set, thus providing the environmental researcher with a wider data base for his decisions regarding, e.g., pollution; and, secondly, the reduced sample volume required for analysis. ICP is not, however, capable of replacing AAS as the technique of choice. The two techniques complement each other. ICP has superior detection limits for traditionally difficult-to-determine elements such as B, Ba, Be, Ti, V and Zr, while AAS is the method of choice for Pb and Hg, as well as semi-metals such as As and Se, particularly where the hydride method or electrothermal furnace is employed. In this poster, the suitability of the ICP and AAS techniques are compared for the analysis of water and related environmental samples, showing how both techniques complement the environmental analysts' armamentarium.

THE DETERMINATION OF TRACE METALS IN SEAWATER



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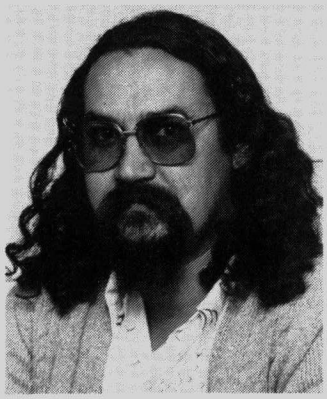
The trace metal content of seawater was used as one of the parameters to assess the effect on the marine environment of the disposal of sewage from the Green Point outfall into Table Bay.

The low metal concentrations found in seawater require preconcentration of a large volume of water by solvent extraction using NaDCC and chloroform. Analysis is completed by standard flame AAS after back extraction into nitric acid.

The efficient extraction of the metal-DCC complexes into chloroform is dependent on uniform and consistent shaking of the one-litre separating funnels. Two types of mechanical



shakers were evaluated, viz. a horizontal oscillating shaking and a shaker capable of inverting the separating funnels. Horizontal shaking of the funnels resulted in incomplete extraction which was reflected in high blank peaks. Inversion of the funnels, however, increased the efficiency of extraction and resulted in an improvement in the 1,0 μ/ℓ standard peak height to the blank peak height ratio.

CN Windt

AN INTEGRATED COMPUTER SYSTEM FOR A WATER ANALYSIS LABORATORY

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When processing large numbers of samples, a great deal of time is spent on recording sample information, calculating results and writing data on report forms. Automation can do away with a lot of these manual procedures, thereby reducing the time between receiving a sample and the final result becoming available. The analytical laboratory of the NIWR adopted a policy of automation from its inception and has reached the stage where approximately 120 000 analyses are carried out on 12 000 samples per year.

To manually handle the data associated with this number of analyses required 40 to 45% of the available time, leaving little scope for developing and improving methods. In an effort to eliminate as much as possible of this tedious, time-consuming task, it was decided to install a computer system that could be linked to the available automated and other laboratory instrumentation.

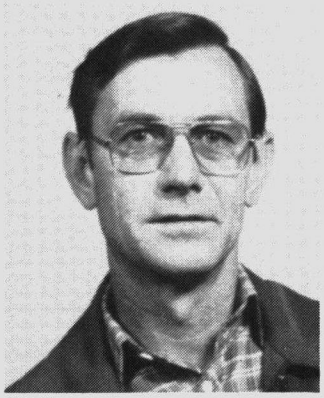
The hardware of the system consists of a 1Mb CPU, an 80 Mb disk, a 1600 BPI tape drive, a digitising tablet, four VDU's, a plotter and two printers. The software to cope with the instruments and administrative tasks was designed and developed around the well-proven, existing procedures. A brief description of the software follows.

Information on and the analyses required for a sample or batch of samples is entered into the computer on receipt and a unique number is allocated to each sample by the computer. From this information lists can, on request, be compiled for specific analyses. When the analyses are carried out, the data can be entered into the databank in one of the three ways. The results can either by calculated manually and keyed in or the strip charts from the recorders can be digitised or the analyses can be run automatically.

Once all the analyses for a specific batch of samples are completed, a preliminary report is printed for inspection of the results. At this point calculations, such as the chemical balance of a sample, can be carried out or, if necessary, analysis on some samples can be repeated. Once the person in charge of the laboratory is satisfied that everything is in order, the final report is printed and returned to the sender.

A facility also exists for carrying out retrospective searches in order to combine the results of the same sampling point over a time period and to perform certain statistical calculations on these results.

DETERMINATION OF ORGANIC COMPOUNDS IN WATER



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There is an increasing awareness regarding the deterioration of our limited drinking water supplies as a result of the industrial and population explosion as well as the contribution from surface run-off and atmospheric deposition.

Analysis of organic compounds serve to evaluate possible effects on the health of the water consumer. As a result of the complexity of organic compounds in a water sample, many direct and indirect methods for their determination have been developed.

Some of the indirect methods, e.g. COD, BOD and OA are based on the amount of oxygen consumed by organic material. These methods are simple and rapid but non-specific. Furthermore, inorganic compounds may interfere and some organic compounds are not affected by these tests at all.

The total organic carbon (TOC) determination is a direct and specific measurement of the organic content of a water sample. TOC determinations are based on the photocatalytic oxidation of organic material in a water sample to carbon dioxide which in turn is measured by infrared spectroscopy. The interference of inorganic carbon is eliminated by prior acidification of samples to pH 2 and purging.

Present technology enables the identification of a fraction of this total organic content only.

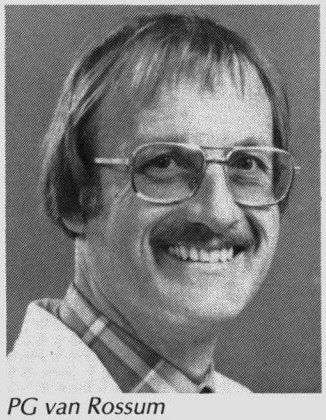
Total organohalogen (TOH) is the total content of halogenated organic material in a water sample. This determination quantifies the total molar amount of organically bound halogen but does not differentiate between the organic compounds concerned.

Gas chromatographs are standardized for quantitative detection of a wide spectrum of base/neutral compounds as well as phenolics. For the identification of specific organic compounds, GC/MS methodology is applied. The mass spectrometer is widely used to determine mass fragmentation patterns by which compound structure can be formulated for further confirmation.

HPLC is especially useful for the analysis of non-volatile and unstable compounds. Some advantages of HPLC analysis are that lower temperatures can be used and both the mobile and stationary phases can be varied to increase selectivity.

The need for new methodology will always exist and will require advanced concepts to enable further identification.

THE ISOLATION AND IDENTIFICATION OF ORGANIC MUTAGENS



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Organic mutagens are organic compounds which can induce permanent, transmissible genetic changes, usually in a single gene. Some of these mutations can lead to serious illnesses such as cancer. Organic mutagens are, or can enzymatically be converted to, electrophilic reactants. They include alkylating agents, polycyclic aromatic hydrocarbons, aromatic amines

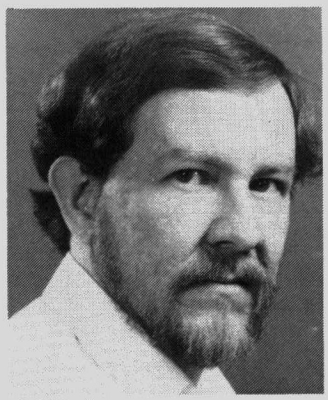
DW Hassett

and nitroso compounds, and can enter the human body via tobacco smoke, food, medicine, cosmetics, air and drinking water. Many of the mutagens originate from industrial and other human activities. Hazardous compounds, which are formed when water which contains organic material such as humic acids is chlorinated, are a major source of mutagenic activity in drinking water supplies world-wide.

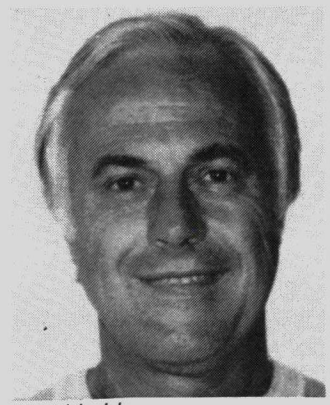
In an evaluation of a wide variety of potential methods for the isolation and identification of organic mutagens in drinking water, success has been obtained with the following procedure. The Ames *Salmonella* mutagenicity assay was used for the detection of mutagenic activity. Four tester strains in the presence and absence of liver homogenate were included to ensure the detection of a wide variety of mutagens. Mutagens were recovered from drinking water by absorption onto non-ionic XAD resins followed by desorption with acetone. Organic compounds in the crude extract, obtained after evaporation of the acetone, were successfully separated by means of gradient silica gel chromatography followed by permeation and thin-layer chromatography. Various conventional separation techniques proved unsuitable because many organic solvents lack the required purity and compatibility with the Ames test. The mutagens are decomposed or deprived of activity by various separation procedures. Reversed phase high pressure liquid chromatography cannot be used because irreversible precipitation of the material to be separated can occur. Mutagens were identified by direct inlet mass spectroscopy, because the conventional capillary column gas chromatography/mass spectrometry combination cannot be used for these compounds.

The above procedure made it possible to identify four distinguishable groups of mutagens in a conventionally treated drinking water supply. One of these groups consisted of nitraoarenes, which are among the most potent mutagens known today. Various shortcomings of the procedure, such as the recovery of highly polar and volatile mutagens, and the detection of mutagens to which the Ames test does not respond, remain to be resolved.

SAMPLING AND GC/MS ANALYSIS OF PETROLEUM HYDROCARBONS IN THE OCEAN SURFACE MICROLAYER



AC Butler



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Petroleum contamination of the marine environment affects numerous compartments of the oceanic ecosystem. The surface microlayer, with its associated neustonic organisms, is susceptible to disruption of its ecological function as a result of the tendency of lipophilic pollutants to attain far higher concentrations at the surface than in the water column.

Sampling of this layer has been achieved with a variety of apparatus, including glass plates, mesh screens, germanium wafers, rotating drums, Teflon discs, freezing probes, and plastic films polymerized *in situ* on the water surface. The Teflon disc chosen for this study was selected primarily for low cost and ease of use at sea. Additional advantages of this sampler are its facile absorption of lipophilic compounds, and the minimal amount of water entrained with the sample. Swabbing of the disc surface with pre-extracted, pentane-soaked cotton wool is used to retrieve the lipids for subsequent extraction and clean-up prior to analysis by high-resolution gas chromatography with flame ionization detection (HRGC-FID) and high-resolution gas chromatography/mass spectrometry (HRGC/MS).

Analysis of both the saturated and polycyclic aromatic hydrocarbon fractions by fused silica capillary GC-FID yields such diagnostic parameters as n-alkane distribution, carbon preference index, and alkane and polycyclic aromatic hydrocarbon 'unresolved complex mixtures'.

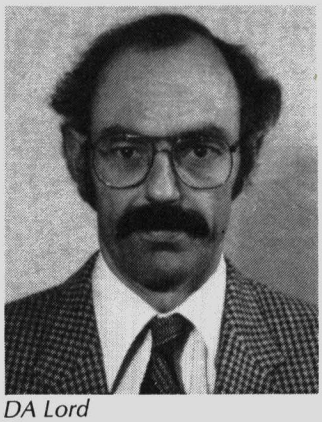
Mass fragmentography performed on a computerized GC/MS provides information on the structure and isomerism of steranes and hopanes in the spilled oil.

Any similarities found between samples on the basis of the GC-FID results can be compared with those revealed by the biomarker characteristics obtained from GC/MS.

It would appear that hydrocarbon concentrations measured in the microlayer, using the Teflon disc, are notably higher than those found by some of the other techniques which is possibly attributable to the entrainment of a considerable amount of diluent water with samples taken by, for example, a stainless steel mesh sampler.

A PROCEDURE FOR ESTIMATING n-OCTANOL/ WATER PARTITION COEFFICIENTS FOR ORGANIC CHEMICALS

AC de Kock



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The ratio of a chemical's concentration in the octanol phase to its concentration in the aqueous phase of a two-phase n-octanol/water system is defined as the octanol/water partition coefficient (K_{ow}). Its magnitude has come to represent the tendency of a chemical to partition itself between the organic and aqueous environmental compartments.

Several methods can be used for measuring or estimating K_{ow}. In recent years there has been considerable interest in the use of reverse-phase high performance liquid chromatography (RPHPLC) for estimating K_{ow}.

This study was undertaken to etablish (a) whether the estimation of K_{ow} by RPHPLC, using commercially available equipment and an unmodified commercial reverse phase column, will give sufficiently representative information in comparison to that obtained by direct calculation, using fragment constants and (b) the relationship between K_{ow} and the chromatographic capacity factor (k^1) of organic compounds. The solvent system used was 80:20 (v/v) methanol: water and the flow rate was 1 $ml.min^{-1}$. The chromatographic capacity factor (k^1) of each compound can be calculated from the equation.

$$k^1 = (t_r - t_o)/t_o$$

where t_r is the retention time of the compound (retained peak) and t_o is the retention time of an unretained peak (in this case, pure methanol).

A plot of log k^1 values thus obtained versus K_{ow} values obtained from the literature yielded a linear relationship expressed by the equation

$$\log K_{ow} = 3{,}91 \log k^1 + 2{,}11 \quad (r = 0{,}95)$$

The RPHPLC method satisfactorily demonstrated the usefulness of RPHPLC for the measurement of K_{ow} values and that it is sufficiently accurate for the evaluation of K_{ow} values of compounds for correlation with their biological activity. The HPLC technique is fast and reproducible and samples need not be pure since contaminants do not interfere with k^1 determinations.

Compounds with widely varying aqueous solubilities were examined. These included benzene, naphthalene, dieldrin, chlorpyrifos, lindane, DDT, hexachlorobenzene, di-octyl phthalate as well as several PCB congeners. For these, corrected PRHPLC K_{ow} values of 2,26; 3,36; 4,8; 4,8; 3,36; 5,62; 6,80; 7,82 and 7,66 for 2,2',4,4'15,5' hexachlorobiphenyl were measured respectively.

We would recommend that compounds with K_{ow} values greater than 5 be subjected to particular scrutiny.

K_{ow} values are very useful in indicating the relative ability of various compounds, when introduced into the environment, to partition into the lipid-containing compartment of an aqueous environment. The polychlorinated biphenyls are of particular concern in this regard. Their very great stability coupled to their high K_{ow} values ensure firstly their accumulation in aquatic organisms as well as their persistence in an aquatic environment.

DETERMINATION OF THE UPTAKE AND LOSS OF POLYCHLORINATED BIPHENYLS BY MARINE ORGANISMS

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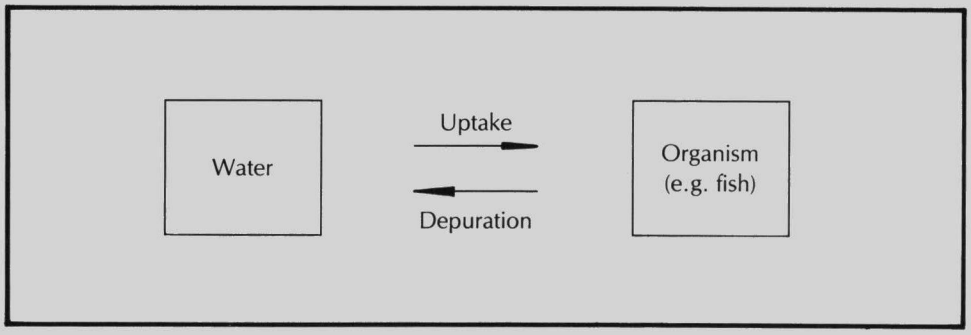
The extent to which a chemical will accumulate in an organism is the combined result of the competing processes of uptake, distribution, transformation and excretion.

PCBs are extremely chemically stable, and have a very lipophilic nature (as indicated by their high n-octanol/water partition coefficient). This means that they are rapidly accumulated by aquatic organisms, and are slowly depurated. Their chemical stability (no metabolism) enables this process of uptake and depuration to be readily followed.

Laboratory studies of uptake are normally restricted to the study of bioconcentration (the direct uptake from water through gills and ephithelial tissue). The process is simply represented by a two compartment box model.



Using first order kinetics and performing a material balance on the two compartments, the rate of change of contaminant concentration in the test organism is given by

$$(dCf)/(dt) = k_1 Cw - k_2 Cf$$

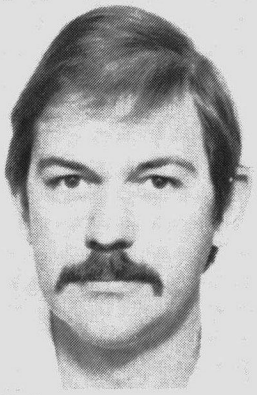
where Cf = concentration in fish (test organism) at any time t,
Cw = concentration in water
k_1 = first order rate constant from water to fish;
k_2 = first order depuration rate constant from fish;
t = exposure time

Both k_1 and k can be found experimentally.

Laboratory studies were undertaken using a commonly occurring estuarine fish, the Cape stumpnose (*Hepsetia breviceps*). For Aroclor 1260 as the test material, it was found that the depuration rate constant is approximately 1 to 4 x 10^{-2} days, implying a half life during dupuration of 20 to 50 days. However, uptake rate constants of 120 to 350 $days^{-1}$ were measured implying a half life during uptake of between 3 to 10 minutes! This implies very rapid absorption of the chemical from water flowing past the gills, followed by complete retention in the fish fat.

These data demonstrate that short exposures of high concentrations of stable lipophilic compounds such as PCBs in water can be as harmful as protracted exposures to low concentrations of these compounds.

ANALYSIS OF PHENOLIC COMPOUNDS IN WATER



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Phenolic compounds are hydroxy derivatives of benzene and occur in domestic and industrial effluents, natural waters and potable waters.

Chlorination of these waters can lead to the formation of chlorinated phenolic compounds which can impart unacceptable tastes and odours to the water. Some chlorinated phenolic compounds are hazardous to health.

Standards for phenolic compounds in water for South African domestic use are contained in the SABS specification 241 of 1984. In these specifications there are two sets of criteria, namely a recommended maximum limit of 5 $\mu g/\ell$ phenolic compounds (as phenol) and a maximum allowable limit to 10 $\mu g/\ell$ phenolic compounds (as phenol). These results are based on the use of SABS method 211 or equivalent.

It is known that method 211 and equivalent methods are unable to detect all types of phenolic compounds. Only 3 of the 11 phenolic compounds listed as priority pollutants by the United States Environmental Protection Agency (USEPA) can be detected.

The Rand Water Board's laboratory decided to develop a method whereby individual phenolic compounds could be analysed. Initial work was restricted to the 11 USEPA phenolic compounds.

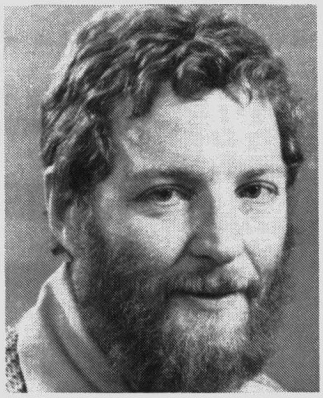
A 1 litre sample is acidified and extracted with dichloromethane. The extract is evaporated/concentrated by Kaderna Danish evaporation. The basic and neutral extractables are removed from the extract by a caustic 'back-extraction'. The acid extractable phenolic compounds are finally extracted by acidic extraction prior to analysis.

Analysis is performed by capillary gas chromatography with flame ionisation detection.

Extraction efficiencies range from 13% to 94% and the method is linear up to 50 $\mu g/\ell$. Relative standard deviations vary from 3,8% to 10,3%. The detection limit of the method is 1,0 $\mu g/\ell$.

This method is an accurate and reliable procedure for the analysis of phenolic compounds in potable waters, natural waters and industrial/sewage effluents. The method can be expanded to include any acid extractable pollutant requiring quantitive analysis.

THE DETERMINATION OF FREE AND TOTAL CHLORINE RESIDUALS



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Chlorine added to waters containing ammonia and certain organic nitrogenous compounds results in the formation of chloramines. These chloramines generally have weaker oxidizing or disinfecting properties as compared to free chlorine. Chloramines, however, tend to have a longer life in water and are toxic to fish. It is therefore important for plant personnel operating chlorine dosing systems to be able to both accurately measure chlorine residuals, and to differentiate between the various active chlorine species present. It is also important for managers, supervisors and engineers to know of the various analytical methods and their limitation so that the best and most practical method can be used in each situation.

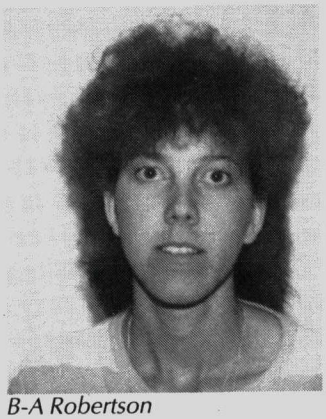
The various methods available for chlorine determination may be divided into the following groups depending on the specific requirements and the type of water being chlorinated.

Field methods. In South Africa, the most popular methods for measuring chlorine concentrations are the DPD and the orthotolidine comparator methods. The orthotolidine method has generally lost favour worldwide because of the toxic nature of orthotolidine. However, it is still fairly widely used in South Africa, especially in swimming pool tests kits.

Laboratory tests. Various methods can be used for laboratory tests. A knowledge of the limitations of each method is necessary so that the best method can be chosen for each application. The iodometric method is simple and accurate, but interferences by nitrites, ferric iron and oxidized manganese can be quite considerable. A back titration iodometric procedure is recommended for wastewater analysis. Iron and nitrite interference can be minimized in the back titration method, but manganese will still interfere. The amperometric titration method is a well accepted standard method for chlorine analysis. Some difficulty may be experienced differentiating between chlorine species, however. Electrode contamination by other metals may also pose a problem. The DPD methods are widely accepted, but interferences from oxidized manganese and high concentrations of combined chlorine in the free chlorine determinations should be noted. Two other methods seldom used in South Africa are the Leuco Crystal Violet method, and the Syringaldazine (FACTS) method. Both these methods are accurate and suffer from fewer interferences than the other methods.

Instrumental methods. Instruments for chlorine measurement have been developed for continuous monitoring purposes, or for simple, more accurate field determinations. These instruments generally employ either the amperometric titration principle, the DPD principle or the orthotolidine method.

DETERMINATION OF FAECAL STREPTOCOCCI



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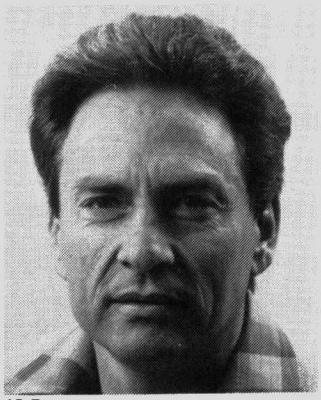
The faecal streptococci used as indicators of faecal contamination consist mainly of *Streptococcus faecalis* and its subspecies *liquefaciens* and *zymogenes,* as well as *S. faecium, S. bovis, S. equinus* and *S. avium.* They represent Lancefield's Group D streptococci, except *S. avium,* which belongs to Group A. The term 'enterococci' which is sometimes erroneously used in this regard, refers only to *S. faecium,* and *S. faecalis* and its subspecies. Faecal streptococci have valuable features as indicators of faecal pollution. They are specific because their normal habitat is the intestinal tract of humans and other warm-blooded animals. The only exception is *S. faeclis* subsp. *liquefaciens,* which may also be associated with vegetation, insects, and certain types of soils. Identification of species yields valuable information on the source of pollution. For instance, a predominance of *S. bovis* and *S. equinus* indicates pollution due to the excrement of non-human, warm-blooded animals. Since *S. bovis* and *S. equinus* have limited survival times outside of their natural habitat, their presence in water indicates very recent contamination. Faecal coliform/faecal streptococci ratios greater than 4,1 indicate that pollution is predominantly of human origin, and ratios of less than 0,7 of domestic animal origin. Faecal streptococci proved particularly useful as indicators of the quality of seawater at bathing beaches because their counts were found to correlate with the incidence of gastroenterites in bathers.

Following an evaluation of the wide variety of methods described for the determination of faecal streptococci, a membrane filtration procedure using commercially supplied m-Enterococcus Agar was selected for the analysis of sewage, raw and treated drinking water supplies, and polluted seawater. Inverted plates are incubated for 48 h at 44,5 ± 0,25 °C in closed containers. Various publications recommend an incubation temperature of 35 °C, but 44,5°C generally yielded higher counts for all the waters tested in this study. The method has the advantage that the pink to dark red colonies of faecal streptococci are usually unmistakable. Since the growth medium is highly selective, there is rarely interference by other organisms, and virtually all colonies are faecal streptococci. The commercial API 20E Strep system proved convenient for the identification of isolates.

DIE BEPALING VAN KLOSTRIDIA



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Clostridium perfringens is 'n hoogs spesifieke indikator van fekale besoedeling. Sommige ander klostridia is nie noodwendig van fekale oorsprong nie omdat hulle ook in grond, plantmateriaal en sekere wateromgewings kan vermenigvuldig. Algemeen gesproke dui die teenwoordigheid van klostridia in water egter op besoedeling met 'n betekenisvolle moontlikheid van fekale oorsprong. Daarbenewens is die teenwoordigheid van klostridia in drinkwater ongewens omdat hulle opportunistiese patogene is wat verskeie infeksies kan veroorsaak. Aangesien klostridia gewoonlik in groter getalle as patogene mikroörganismes in water voorkom, en die spore van klostridia langer lewensvatbaar bly in water en meer bestand is teen behandelingsprosesse as vegetatiewe organisme of virusse, beteken die afwesigheid van klostridia dat water veilig is. Alhoewel daar dus goeie redes bestaan om klostridia by die ontleding van waterkwaliteit in te sluit, word dit selde gedoen omdat aanbevole metodes dikwels omslagtig en duur is.

'n Vergelykende studie het getoon dat die volgende relatief eenvoudige en ekonomiese metode betroubare resultate lewer. Filtreer geskikte volumes water (100 mℓ, 10 mℓ, 1 mℓ of verdunnings) deur membrane met 'n poriegrootte van 0,45 μm. Plaas die membrane onderstebo op 'n triptosesulfiet-sikloserien agarvoedingsbodem (TSS) en bedek met 'n lagie TSS-agar. In sommige metodes word die TSS medium met eiergeel verryk, maar die verskil in tellings was meesal weglaatbaar klein en regverdig nie die addisionele koste en arbeid nie. Na bebroeiing vir 16 h by 35 °C in 'n anaerobiese houer, kan die duidelike swart kolonies van klostridia getel word. Toetse op 'n wye verskeidenheid van waters het aangetoon dat sowat 26% van klostridia, wat volgens hierdie metode bepaal is, *C. perfringens* was. In die geval van 'n alternatiewe voedingsbodem wat polimiksien bevat, was 94% van die isolate *C. perfringens*. Hierdie voedingsbodem word egter nie vir die roetine-ontleding van drinkwater aanbeveel nie omdat dit laer tellings van klostridia lewer en polimiksien baie duur is.

Op grond van uitgebreide navorsing oor die mikrobiologiese kwaliteit van water word 'n perk van geen klostridia per 100 mℓ aanbeveel vir drinkwater wat volgens hierdie metode ontleed word. Indien klostridia wel teenwoordig is, word identifikasie van die isolate aanbeveel omdat die teenwoordigheid van *C. perfringens* fekale besoedeling bevestig. Aangesien die spore van klostridia langer in water kan oorleef as ander indikatore soos kolivormbakterieë of fekale streptokokke, is klostridia veral geskik vir die waarneming van besoedeling wat relatief lank gelede plaasgevind het.

DETECTION METHODS FOR COLIPHAGES

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Coliphages generally outnumber enteric viruses and survive at least as long in water environments. This implies that water can be considered free of enteric viruses if coliphages are absent. Another important advantage of coliphages as indicators of the virological quality of water is that they can be detected by simple, rapid and economic methods.

Following comprehensive research on methods for the detection of coliphages in water, two techniques are recommended. One is a double-agar-layer assay for wastewater or untreated water with relatively high coliphage counts, and the other a single-agar-layer assay for

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100 mℓ samples of drinking water. In the former, 2,5 mℓ of soft agar, 0,2 mℓ of an overnight host culture and 1,0 mℓ of the test sample are mixed in a test tube at 45 °C and poured as a top layer on a nutrient agar bottom layer in a 90 mm diameter petri dish. The test is carried out in tenfold to obtain counts of coliphages per 10 mℓ. In the case of very high coliphage counts, tests are carried out on 1 mℓ volumes of appropriate dilutions of samples. In the assay for drinking water, 100 mℓ of the test sample is mixed with 100 mℓ of a melted nutrient agar concentrate, 1 mℓ of a calcium chloride solution and 5 mℓ of an overnight host culture in a 250 mℓ medical flat at 45 °C. The mixture is poured as a single layer in ten 140 mm diameter petri dishes. In both assays *Escherichia coli* strain C (ATCC 13706) is used as host, and divalent cations are added to the medium to facilitate the adsoption of phages. When necessary, a resistant strain is used and nalidixic acid is added to inhibit interfering microbial growth. Plaques are counted after 6 to 18 hours incubation at 35 °C.

Detailed studies on raw and treated waters showed that a coliphage limit of nil per 100 mℓ, on the basis of the above assays, is a reliable and practical indicator of the virological safety of drinking water, including supplies directly reclaimed from wastewater. The single-agar-layer assay proved suitable for the routine analysis of drinking water supplies, and can be carried out in any microbiological laboratory.

DETERMINATION OF COLIFORM BACTERIA: A COMPARISON

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In 1983 it became evident that the procedures for determining the coliform and the *Escherichia coli I* content of water in the RSA were to be replaced with m-Endo-LES and m-FC medium, respectively. Consequently, the authors decided to subject a representative number of colonies counted on these media to confirmation and completion as carried out previously, in order to compare this with results obtained in the past. Waters tested were catagorised as indicated below.

The results obtained on m-FC will be referred to as 44,5 °C coliforms, those on m-Endo will be presented as 37 °C coliforms. For the 44,5 °C coliforms and the 37 °C coliforms, the tests previously employed for confirmation and completion were applied. Analysing the final results obtained on natural waters, it was found that the following percentages were not 44,5 °C coliforms:

dark blue colonies (DB) 27,8; blue centre (BC) 96,5: greyish green (GG) 45,9 and non-lactose fermenters (NLF) 100%. On the other hand the percentages of final effluents not being 44,5 °C coliforms were: DB 40,6; BC 99,9; GG 74 and NLF 64,3. The data for raw sewage was DB 72,7; BC 54,8; GC 78,5 and NLF 72,1.

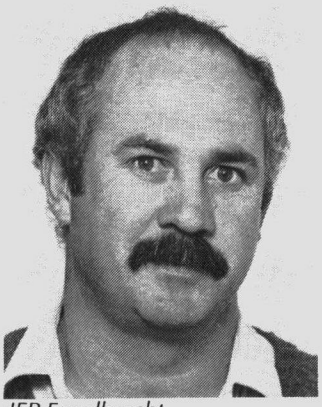
The current practice of confirming the 44,5 °C coliforms will hold for natural waters but for polluted waters, confirmation should be extended.

For natural waters colonies picked from the 37 °C coliforms, the results obtained for not being coliforms were as follows:

metallic green (MG) O; wine red (WR) 93,9; pink (P) 85,7 and NLF 97,7. For final effluents, the following percentages were obtained:

MG 0 and WR 12,9; while raw sewage gave MG 0. The current practice for the 37 °C coliform determination gives reliable counts for natural waters, but the presence of the WR and the P colonies cannot be ignored in contaminated waters.

BEPALING VAN *ASCARIS LUMBRICOIDES*-EIERS IN KOMPOS EN RIOOLSLYK



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Die identifisering en kwantifisering van *Ascaris lumbricoides*-eiers in kompos en rioolslyk is 'n groot struikelblok in die analise van monsters deur 'n mikrobiologiese laboratorium.

Vroeëre metodes om eiers van *Ascaris lumbricoides* in water en stoelgang te konsentreer is oorspronklik gebruik om die eiers in kompos en rioolslyk te isoleer. Baie eiers gaan in die proses verlore wat tot vals negatiewe resultate lei.

Steer, Nell en Wiechers het die metodes van Allen & Ridley aangepas deur 'n anioniese wasmiddel by te voeg. Hierdie metode het goed gewerk, maar te veel deposito het agtergebly wat die mikroskopiese werklas gevolglik vergroot het.

Franck het vervolgens die metodes van Allen & Ridley, Steer Nell & Wiechers, Visser & Pitchford en Spencer & Monroe bymekaar gevoeg. Hierdie werk sal onder die titel: 'n Metode vir die kwantifisering van *Ascaris lumbricoides*-eiers in grond, kompos en rioolslyk gepubliseer word.

Hierdie metode, hoewel dit bykans twee uur neem om een monster te voltooi, maak egter seker dat geen eiers verlore gaan nie. Die metode bestaan kortliks uit die volgende stappe. Vyf-en-twintig gram monster word deur onderverdeling verkry wat by 20 mℓ isotoniese soutoplossing gevoeg word. Die mengsel, saam met 0,5 mℓ anioniese wasmiddel, word vir vyf minute in 'n menger gehomogeniseer. Hierna word die inhoud van die menger in die binnefilter van 'n Visser-filter geledig. Met behulp van 'n waterstraal word die mengsel opgebreek en deurgewas na die buitefilter. Dit neem ongeveer twintig minute voordat die monster skoon is. Die inhoud van die binnefilter word weggegooi terwyl die inhoud van die buitefilter saam met sy waswater opgevang word. Hierby word sinksulfaat gevoeg om die eiers te flokkuleer. Dit word dan gesentrifugeer, waarna die bowater deur 'n membraan (poriegrootte 12 μm) gefiltreer word. Die membraan word hierna in 'n broeikas gedroog. Die droë membraan word dan met immersie-olie opgehelder en die eiers word by 'n lae vergroting onder 'n mikroskoop getel.

RECOVERY OF VIRUSES FROM DRINKING WATER USING AN IN-LINE CARTRIDGE FILTER

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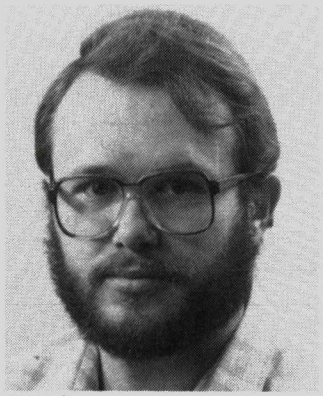
Since human enteric viruses generally occur in relatively low numbers in water, and these numbers may be sufficient to constitute a health risk, assessment of the safety of treated drinking water supplies requires the recovering of low numbers of viruses from large volumes of water. A wide variety of methods, each with its own advantages and disadvantages, is available for this purpose. Ultrafiltration with flat membranes has the highest efficiency of recovery (EOR) but due to clogging it is not practical for volumes of more than 10 ℓ. Adsorption-elution techniques using negatively charged filters are commonly used because volumes of 100 to 1000 ℓ can be rapidly processed. However, their general EOR is low and since the techniques involve the exposure of viruses to extreme pH variations, many viruses are inactivated. In addition, the in-line application is complex because the pH of the water

has to be adjusted to critical low levels and cations have to be added to enhance the adsorption of viruses. Positively charged membranes have recently been developed. They overcome some of the shortcomings of negatively charged membranes and their in-line application for the recovery of viruses from drinking water supplies has been investigated.

AMF-Cuno Virosorb cartridge filters were used. In an apparatus constructed for EOR studies, a stream of tap water, continuously seeded with varying dosages of different viruses, was passed through a cartridge filter. The apparatus automatically neutralized chlorine residuals and measured the volume of water processed. Recovered viruses were released by cycling a solution of 3 g/ℓ beef extract in a pH 9,5 glycine-sodium hydroxide buffer for 5 min through the filter. The pH of the 1ℓ eluent was immediately neutralized. Generally, secondary concentration steps are applied to eluent of such large volumes. Since some viruses are lost during these steps, they were eliminated by directly inoculating the eluents into cell cultures. This was done by converting the eluents into growth medium by the addition of the required ingredients, and by replacing the growth medium of cell cultures with this inoculum.

The procedure has an EOR of about 75 ± 25% for viruses such as polio. The EOR of some viruses, such as reovirus, the SA-11 simian rotavirus and coliphages, is considerably lower. This may be due to inactivation by exposure to pH 9,5 or poor adsorption to the filter at neutral pH levels. The EOR of all viruses decreased when water volumes of more than about 100 ℓ were processed. Although the EOR is significantly lower than that of ultrafiltration, the procedure has the advantage that filters can be applied on site for in-line recovery of viruses from large volumes of water, followed by transportation of the filter to the laboratory for recovery and identification of viruses.

MICROBIOLOGICAL ANALYSIS OF SHELLFISH



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Shellfish feed by filtering large volumes of water at a rate of up to 18 ℓ/h. In this process they do not only accumulate nutrients, but also micro-organisms. Consequently, shellfish harvested from sewage-polluted waters often contain high numbers of pathogenic bacteria and enteric viruses, and their raw consumption frequently results in a variety of intestinal infections.

In an evaluation of various methods for the recovery of micro-organisms from shellfish, the following procedure was selected for research on the microbiological quality of shellfish along the South African coast. Black mussels and oysters are flown alive at 4 to 10 °C from the coast and processed within 48 h of collection. Meat is removed from the shells, pooled and 50 g are homogenized in 350 mℓ sterile distilled water. This suspension is directly used for the determination of standard plate counts using pour plates, coliphages by a double-agar-layer plaque assay, and total coliforms, faecal coliforms and faecal streptococci by membrane filtration techniques. Liquid excreted by the shellfish in transit is directly tested for the latter organisms as well as enteric viruses. Enteric viruses are firmly adsorbed to the meat and they are recovered by a special procedure. The pH of the above meat homogenate is reduced to 4,5 to limit release even further. The homogenate is then centrifuged and the virus-containing pellet resuspended in a pH 7,5 glycine-saline buffer, in which the viruses desorb from the meat. The meat is removed by slow centrifugation. The pH of the virus-containing supernatant is then again reduced to 4,5 for acid precipitation of viruses, which are recovered by high-speed centrifugation and resuspended in a pH 7,5 phosphate buffer. A poly-electrolyte flocculant, Cat-Floc, and chloroform for the inactivation of organisms other than viruses, are added to this suspension. Final centrifugation yields a clear virus containing supernatant which is used for the detection of viruses by inoculation into cell cultures and analysis by enzyme-linked immunosorbent assays.

Comparative tests on seeded shellfish meat showed that the above procedure has an average efficiency of recovery of about 60% for enteroviruses such as polio, but only some 5% for a reovirus and less than 1% for the simian rotavirus SA-11. The poor recovery of some viruses may be due to inactivation by the pH fluctuations.

ENUMERATION OF *LEGIONELLA* BACTERIA

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Legionellosis (Legionnaire's Disease) was discovered in 1976 and various outbreaks with a number of deaths have already been described. The current high incidence of the disease is probably due to conditions in modern air-conditioning and water-cooling systems which favour the multiplication and spread of the causative organisms. Legionellosis and related respiratory illnesses are caused by *Legionella pneumophila,* various other *Legionella* species and related organisms such as *Tatlockia micdadei.* Important features of these organisms include exceptional resistance to conventional water disinfection and treatment processes. Although cases of the disease have been described in South Africa, there are no details on the incidence and behaviour of these organisms in local water environments and treatment processes.

A literature survey and comparison of various procedures showed that the following is a practical method for the enumeration of legionellas in water: Recover the organisms from 1 ℓ samples (or other appropriate volumes) by membrane filtration using 0,45 μm porosity membranes. Suspend the membrane upside down in 10 mℓ sterile water in a suitable screw-cap wide-mouth bottle. Release bacteria from the membrane by sonication for 10 min in an ultrasonic cleaning bath. Carry out three tests on this concentrate for the detection and enumeration of legionellas. Firstly, spread 0,1 mℓ portions of the concentrate, and appropriate tenfold dilutions, onto plates with a buffered charcoal yeast extract (BCYE) agar medium as well as onto plates with the same medium supplemented with 3,0 g/ℓ glycine, 5,7 mg/ℓ vancomycin and 1 mg/ℓ primaricin for selection of legionellas. Secondly, expose a portion of the concentrate to 50 °C for 30 min followed by pH 2,2 for 5 min in order to select for legionellas prior to plating as described above. Incubate all plates at 35 °C for 5 days and purify suspect colonies on BCYE without antibiotics. Thirdly, carry out a fluorescent antibody staining test directly on the concentrate. Identify on colonial morphology (gray, glistening, smooth, convex, slightly moist colonies), failure to grow on blood agar without cysteine, formation of brown pigments on media containing L-tyrosine and confirm by immunofluorescent staining.

This procedure proved successful in tests on water seeded with pure cultures of *Legionella pneumophila,* as well as on the detection of legionellas in various local water environments.

CORRELATION OF THE SEASONAL INCIDENCE OF *LEGIONELLA* BACTERIA IN WATER ENVIRONMENTS AND CLINICAL CASES OF LEGIONELLOSIS

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Legionellosis is a disease caused by the *Legionella* bacterium (L.B.). The clinical manifestations of the disease range from a mild flu-like illness to a severe even fatal pneumonia.

Water is the natural habitat for L.B. in which it coexists with other microorganisms.

There is evidence that the dissemination of *Legionella* is through aerosols of infected water

A Drath-Feingold

(via drifts from cooling towers, humidifiers, evaporative condensers, showers, whirlpools, soil excavations, etc.)

The incidence rate of infections with L.B. is dependent on the exposure of a susceptible population group or individual to the organism. Heavy smokers, alcoholics, persons with underlying lung disease and immuno-suppressed patients constitute the population at risk.

The majority of clinical cases which have been found in South Africa suggests a seasonal infection, which implies seasonal occurrence of the organism in the environment.

Between 1981 and 1985 water samples collected from various places (office buildings, hotels, lakes, mines, etc.) were tested. A total of 343 samples were checked for the presence of *Legionella,* according to the CDC protocol, 177 during summer-autumn and 166 in winter-spring. (Briefly: concentration of sample, Direct Fluorescent Antibody (DFA) testing of the bacterial yield, isolation and identification of the bacteria).

From 177 summer-autumn samples, 109 (61,5%) showed presence of L.B. (on DFA) and 27 (15,2%) were cultured; from the 166 winter-spring samples 77 (46,4%) were positive on DFA and only 5 (3,0%) could be cultured.

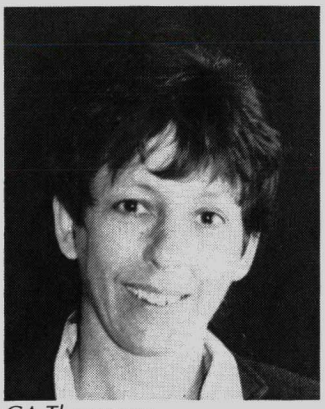
Although *Legionella* can be found in environmental waters throughout the year, the organism is isolated mainly from the samples collected in the warm season. The statistical analysis of the laboratory results is relevant:

Culture summer-autumn/winter-spring $X^2 = 15,19$ $p < 0.001$

DFA summer-autumn/winter-spring $X^2 = 7,97$ $p < 0.01$

The seasonal recovery of *Legionella* from the environment correlates with the seasonality of the clinical cases; the possibility exists that *Legionella* undergoes a latent dormancy-like stage, during the cold period of the year. The low viability probably helps in the conservation of the organism during the unfavourable winter conditions.

A MOST PROBABLE NUMBER METHOD FOR THE ENUMERATION OF POTENTIALLY PATHOGENIC VIBRIO SPECIES



GA Thompson

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The vibrio group of bacteria contain only a few species but most of these are potentially pathogenic either to man or shellfish, or both. The halotolerant properties possessed by many of the species as well as their ecological niche in marine waters, particularly estuaries, has led to several species distribution studies. Concurrently, the role of vibrios in marine-associated disease has been highlighted, especially in recent years. As a result, there is a growing awareness of the need to quantify vibrios, along with *E. coli,* as water quality indicators at shellfish harvesting sites and in marine recreational waters.

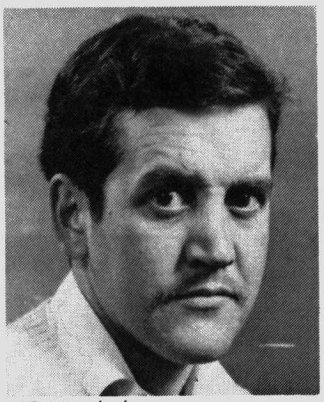
It has been demonstrated that *V. cholerae*-01, the causative agent of cholera, exists naturally in estuaries. However, normal methods of detection (direct culture) do not necessarily reflect their true numbers, as a viable but non-culturable state can be detected using a fluorescent antibody technique. *V. cholerae* non-01, also an estuarine resident, has been implicated in numerous gastro-intestinal infections. It has been postulated that a change of antigenic state from non-01 to 01 can occur. Other potentially pathogenic vibrios include *V. parahaemolyticus,* which is associated with infections acquired through eating shellfish or raw fish, while the halophilic vibrio, *V. alginolyticus* has been implicated in cases of septic wounds associated with marine usage. *V. vulnificus* has been implicated in infectious wounds and in cases of septicaemia traced to ingestion of raw shellfish.

At present, the majority of investigations concerning vibrios involve the use of Moore swabs to detect *V. cholerae*-01 in waters and the examination of shellfish tissue for *V. parahaemolyticus* and *V. cholerae*-01. This poster outlines a method for detection of *V. cholerae*-01 and non-01, *V. parahaemolyticus, V. vulnificus* and *V. alginolyticus* in water and sediment. Selective media and different incubation temperatures are used for recovery of the bacteria. With slight adjustments, the MPN 3 tube 3 dilution method can be applied to shellfish and fish tissue, and is an inexpensive but effective method for vibrio detection. Various concentrations of 1% alkaline-bile peptone water (ABPW) are added to the samples for primary selection; and

ABPW with and without 10% salt is used for secondary selective enrichment of *V. cholerae* and *V. alginolyticus,* respectively. TCBS agar at 30° and 37 °C is used as the final selective medium for these two species. *V. parahaemolyticus* and *V. vulnificus* are primarily enriched in 1% ABPW prior to isolation at 43 °C on salt tryptone soya agar with added tetrazolium chloride. Identification to species level of all typical colonies is achieved using a multipoint inoculator/microwell system which allows for the simultaneous testing of 48 isolates per 97 mm petri dish.

ENZYMES AS TOXICANT DETECTORS

DW de Haas



NC Metelerkamp

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Enzymes are proteins which catalyze specific chemical reactions under mild conditions. In certain cases, the product(s) of such reactions are relatively easily identified. Two examples are firefly luciferase (produces light by a bioluminescent reaction), and urease (releases ammonia from urea). In the former, light output is measured by a luminometer; in the latter, ammonia formation causes a rise in pH. Where toxicant molecules inhibit the catalytic mechanism of the enzyme reaction, the occurrence and rate of this reaction becomes a test for the presence of toxicants in the water sample.

The firefly luciferase reaction may be represented as:

$$E + LH_2 + ATP \rightarrow E.LH_2AMP + PP_i \quad (1)$$

$$LH_2AMP + O_2 \rightarrow E.P + AMP + CO_2 + \text{light} \quad (2)$$

where

E	=	luciferase	PP_i	=	pyrophosphate
LH_2	=	D(–) luciferin	ATP	=	adenosine triphosphate
P	=	oxyluciferin	AMP	=	adenosinemonophosphate

D(–)luciferin can be chemically synthesized and is commercially available along with highly purified luciferase from firefly tails. Suspended in neutral buffer, these components give rise to the bioluminescent reaction upon addition of ATP as energy source. The rate of the reaction can be determined by measuring the peak light output using a luminometer. In preliminary tests, the following types of toxicant have shown inhibition of the bioluminescent reaction: heavy metals (well-known protein denaturants) and certain organic pesticides (such as pentachlorophenol, a fungicide which probably inhibits the enzyme by hydrophobic ligand-binding).

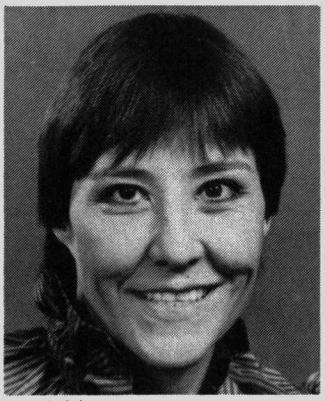
Urease catalyses the following reaction:

$$NH_2.CO.NH_2 \text{ (Urea)} + H_2 \rightarrow CO_2 + 2\ NH_3 \text{ (Ammonia)}$$

A techique, utilizing the pH indicator phenolphthalein, has proved successful for the qualitative determination of ammonia from this reaction. A positive reaction is indicated by a colour change from colourless to pink after addition of the indicator. Urease is known to be inhibited by heavy metals. Preliminary tests have shown that certain heavy metals can be detected by this method at concentrations considered to be the maximum permissible limits for drinking water. In both the luciferase and urease tests, the ratio of enzyme to toxicant play a decisive role.

Current research is aimed at expanding the range of toxicants which can be detected using enzyme-catalyzed reactions. It is hoped to develop field applications for such tests where a need exists for the rapid identification of health-hazardous levels of toxicants in water.

AN IMPROVED BACTERIAL TOXICITY TEST



JL Slabbert

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Bacteria have several advantages as test organisms for hazardous chemicals in water. They respond to most chemicals which affect higher organisms because they have similar metabolic pathways, enzyme systems, genetic control mechanisms and semipermeable membranes. They lack complex homeostatic systems which means that deleterious effects can often be observed within minutes. Because they are easy to grow, it is possible to use large numbers of organisms in tests and obtain excellent statistical accuracy. In addition, bacteria can be cultured and maintained by simple and economic methods.

A number of assays based on the inhibition of bacterial growth have been described. These generally involve an incubation period of 16 to 24 h. The short generation period of 20 to 30 min of many bacteria, however, allows for more timeous measurements. The following multiplication inhibition test can be carried out within 8 h.

Water samples to be tested are decontaminated by filtration through a membrane of 0,45μm pore size, and dispensed as 45 mℓ volumes in 100 mℓ medical flats. A culture of the test organism, *Pseudomonas putida* strain W, grown overnight at 27 °C, is diluted with fresh minimal medium to a density with an absorption of 0,8, measured spectrophotometrically at 600 nm, 30 min before inoculation. This suspension is added in a ratio of 1:4 to a 12,5-times concentrate of the minimal medium, and used as 5 mℓ volumes for inoculation of water samples. Sterile deionized water is used for control tests. Depending on requirements of statistical analysis of results, each test should be carried out at least in three-fold. Cultures are incubated at 27 °C for 6 h with the flats turned onto their sides at an angle of 10 °. Growth is measured spectrophotometrically. Toxic effects are expressed in terms of percentage inhibition compared with growth of control tests. Effective toxicant concentrations (e.g. EC10 or EC50) can be determined using regression analysis.

Results achieved with this technique compare favourably with that of the most sensitive bacterial growth tests, yet are obtained in half the time. The test is simple, inexpensive and yields reproducible data which are easily interpreted. The test may be applied for the rapid screening of industrial and domestic wastewater for toxicity and the detection of excessive contamination in drinking water supplies.

A PRACTICAL AMES *SALMONELLA* MUTAGENICITY ASSAY FOR DRINKING WATER

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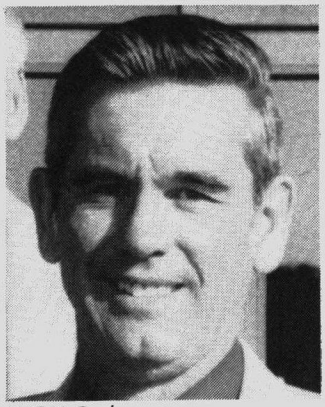
Levels of mutagenic activity in treated drinking water supplies are generally too low for detection by the Ames *Salmonella* mutagenicity assay using conventional plate incorporation or even spot tests. A variety of methods have, therefore, been developed for the recovery or concentration of mutagenic compounds to reach levels which are detectable by conventional Ames tests. However, this approach does not reflect the true picture of mutagenic activity because the recovery and concentration procedures have selective and limited efficiencies of recovery.



WOK Grabow

The following modification increases the sensitivity of Ames plate incorporation assays to the extent that meaningful assessment of the mutagenic activity of drinking water supplies is possible by direct testing of water samples. The modification is based on using the test water to prepare the bottom layer of plate incorporation assays. This means that each plate contains 20 mℓ of the test sample instead of the conventional 0,1 mℓ in the top layer, which theoretically increases the sensitivity of the assay 200-fold. Test water is used to prepare solutions of agar, salts and glucose, which are autoclaved separately, cooled, mixed and poured into 90 mm diameter petri dishes. In negative controls, distilled water is used to prepare the bottom layer. The top layer containing tester strains in the presence or absence of S9 liver preparation, but without test water, is then poured onto the bottom layer, followed by incubation of plates, counting of colonies and calculation of the mutagenicity ratio in the usual manner. Comparative tests on a wide variety of waters showed that, contrary to what might be expected, autoclaving did not significantly affect the mutagenicity of water. This indicates that mutagens generally present in water are not volatile or heat-labile. It has been found that, due to the stability of the mutagens, test water can be concentrated up to four-fold by flash evaporation prior to testing, which increases the sensitivity of mutagenicity assessment even further.

The modified plate incorporation assay proved a practical, rapid and inexpensive method for the direct assessment of the mutagenic activity of drinking water supplies. In addition, comparative studies showed that the method detects mutagens which are not recovered by commonly used recovery procedures. The method proved particularly useful for routine monitoring purposes, and comparison of the mutagenic activity of different water supplies. Analysis of a wide variety of drinking water supplies indicated that a negative result obtained by this method implies that the water is safe for human consumption.

ASSESSMENT OF *MICROCYSTIS* TOXINS IN ENVIRONMENTAL WATERS

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Summer blooms of the planktonic cyanobacterium (blue-green alga) *Microcystis aeruginosa* are a regular feature of many South African impoundments and several cases of livestock deaths have been recorded. The presence of toxic *Microcystis* in water reservoirs constitute a hazard to human health as some of the toxins present are not removed by conventional water treatment processes. Direct evidence of human poisoning as a result of *Microcystis* ingestion exists. *Microcystis* is morphologically and physiologically adapted to succeed in eutrophic environments and increased levels of eutrophication will inevitably lead to more toxic algal problems. Reliable and sensitive methods to assess the toxicity of environmental samples are therefore urgently needed.

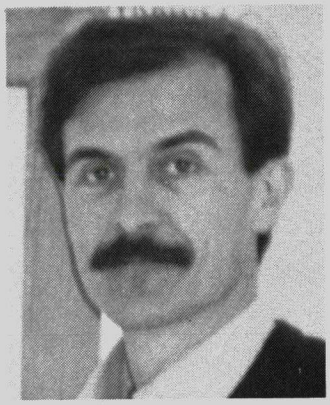
As a first step in assessment of toxicity in field samples, toxic forms of *Microcystis* can be distinguished morphologically on the basis of large, hollow reticulate colonies. A wide range of colony forms exist in *Microcystis* and suspected toxicity should be confirmed by standard mouse tests. Mouse tests are useful to give a yes or no answer but are not sensitive enough to detect low concentrations of toxins. A range of different compounds with toxic properties can be demonstrated in crude extracts of *Microcystis* by using cell culture and hemolysis assays. The most prominent toxic compounds are a group of peptide hepatotoxins known as cyanoginosins. The recent successful isolation and chemical characterization of cyanoginosins now make it possible to develop specific new methods of high sensitivity to detect small amounts of toxins.

Two methods show promise: The first follows a procedure of extracting the toxins in butanol/methanol mixture and concentrating it with reverse phase chromatography and gel filtration. Toxic peaks can be separated by employing high performance liquid chromatography and concentrations estimated by comparison with purified standards. The second new method involves the formation of monoclonal antibodies to the toxins. The low molecular mass of cyanoginosin requires the formation of a complex conjugate involving the purified

toxin, a hapten and a carrier. Spleen cells of mice immunized against the conjugate can be fused with a myeloma cell line to produce hybrid cells that secrete antibodies of a defined specificity. These monoclonal antibodies can be used to develop a number of types of very sensitive enzyme immunoassays. It is expected that routine assessment of environmental samples employing these new techniques will be in progress in the near future.

LANDSAT ANALYSIS OF CALIBRATION DATA FOR CHLOROPHYLL AND TURBIDITY

A Howman



P Kempster

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Satellite remote sensing has been successfully used to detect and quantify chlorophyll a and turbidity in impoundments. Landsat's synoptic, multispectral and regular data capture of the earth's features makes it an ideal platform for synoptic quantification of water quality conditions visible to the satellite. The quantification process requires that the satellite reflectance data be calibrated with the surface reference data. Crucial to the accuracy of the calibration is that the surface reference data should be representative of the prevailing conditions in the impoundment.

Surface and integrated chlorophyll a and turbidity data were collected on Roodeplaat Dam. Seven sampling sites were specifically chosen to be representative of the prevailing conditions and seven other sampling sites were determined using a random number generator.

CALMCAT*, a model involving Canonical Correlation Analysis, makes possible the simulation of chlorophyll a and turbidity, for each 80 m x 80 m pixel of the surface area of an impoundment, using calibrated satellite reflectance data. Simulations were made using both sets of data, these being tested with surface reference data not previously used in the calibration process.

The poster presents the results of the analysis, which indicated that the representatively chosen data set provided more accurate simulations than did the randomly chosen sampling sites. Of critical importance, therefore, in the calibration of the satellite reflectance data is the choice of a suitable surface reference data calibration set.

CALMCAT* – Canonical Analysis Landsat Model of Chlorophyll a and Turbidity.

A MULTI-CHANNEL METERING PUMP FOR INDEPENDENT DOSING OF VARIABLE LIQUID VOLUMES

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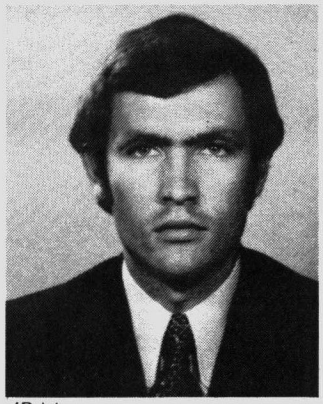
Metering pumps are widely used in the food, chemical and pharmaceutical industries for simultaneous dosing of additives such as different flavours, colouring, various chemicals and



JP Maree

by laboratories for pumping small fluid volumes. The requirements of such a pump are that it be cheap, accurate and require little maintenance.

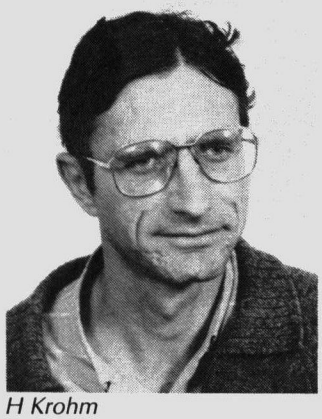
The National Institute for Water Research (NIWR) has developed a cylinder-type peristaltic pump for this purpose. It has one driving mechanism, which drives a number of pump cylinders via a common plate shape lever. The lever is connected by means of pivotal connections to the support of the pump cylinders. A pump action is obtained by using one part of a cylinder for suction, and the other part for pumping. Pumping in one way is obtained by operating a valve which is synchronized with the piston in such a way that the suction side of the cylinder is always connected to the point from where pumping is needed, and the pump part to the point to where it is pumping.

The main features of this pump are its multi-channel nature and the variable dosing rate of each channel, which can be set independently by varying the stroke length. The latter is achieved by changing the distance of the pump cylinder from the axis of the lever. Other features of the pump are:

* it is accurate, as it is a positive displacement pump, and does not suffer from wearing of its active parts
* it requires little maintenance as little material stress is applied
* it is competitive costwise as it requires only one driving mechanism for an unlimited number of channels
* it can deal with highly corrosive liquids.

A provisional patent has been registered on the invention and interested parties are invited to negotiate manufacturing and marketing rights with the NIWR. These activities could also be undertaken jointly.

WATER SOURCES: STRATEGIES FOR HANDLING SAMPLES GENERATED BY CONSUMER COMPLAINTS



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Consumer complaints about drinking water are normally as a result of a bad taste or smell. The presence of cutting oil in the water accounts for a large proportion of these complaints. Pollution of recreational water sources is another area which leads to reaction from the public. Fish mortalities, in dams in particular, have been a problem on a number of occasions.

While low levels of dissolved oxygen after heavy rains are often responsible for the latter phenomenon, organic pollution in the form of phenols has also been implicated.

Strategies for handling non-routine water samples in response to a complaint are discussed.

Pollutants are extracted from the samples by liquid – liquid extraction or XAD resin absorption techniques. Identification and quantification are carried out using gas chromatography and mass spectrometry.

THE IMPORTANCE OF APPROPRIATE CHEMICAL QUALITY DATA IN RESEARCH ON HEALTH ASPECTS OF WATER

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C W Derry

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Medical School,
University of Cape Town,
Observatory 7925
Department of Health Services,
Cape Technikon,
Cape Town

Studies as to the effect of the chemical quality of potable water on human health require accurate data regarding morbidity (disease), mortality (death), demography (population characteristics) and the chemical quality of treated water as supplied to consumers in discrete areas with suitable population numbers to enable meaningful study.

Two relevant studies being carried out by the Department of Community Health of the Medical School, University of Cape Town, are designed to investigate the relationship between the consumption of reclaimed water and a number of health indicators, and the relationship between a number of water ions in treated water and the mortality rates for cardiovascular and ischaemic heart disease.

Durig the period of study, the establishment of a limited potable water data base for South Africa for the years 1978 to 1982 was necessary and this revealed a number of problems, including:

1. The incompatability of data kept by water boards, research institutes and local authorities, owing to, inter alia, the irregularity or infrequency of sampling and the unstandardized approach regarding the factors analysed and the analytical techniques used.

2. The inaccuracy or unavailability of data from some authorities because of the lack of trained sampling or analytical staff, or the existence of administrative shortcomings.
3. The lack of a national data bank for potable water to complement the relatively extensive banking of raw water data which is at present carried out.

In order to improve the poor quality of the present data, the following recommendations are made:

1. That a national data bank for potable water quality be established on the lines of the data bank for raw water at present operated by the Hydrological Research Institute.

2. That suitable guidelines or standards are produced relating to the frequency and method of collection of samples, the method of analysis, the submission of data to the central repository and the subsequent coding, storage, representation and availability of data.

DISSOLVED ORGANIC CARBON ANALYSER RF10

The RF10 autoanalyser is an on-line system utilizing ultraviolet/peroxodisulphate oxidation of the organics in a water sample followed by infrared detection of the carbon dioxide liberated. Inorganic carbon is removed by acid treatment and gas-liquid separation. Oxygen is used for inorganic stripping, sample segmentation and as carrier gas to the NDIR detector.

The model RF10 integrates all operations, including data handling with a micro-computer. The RF10 is programmed, contains a keyboard and communicates with the operator via a LC-display.

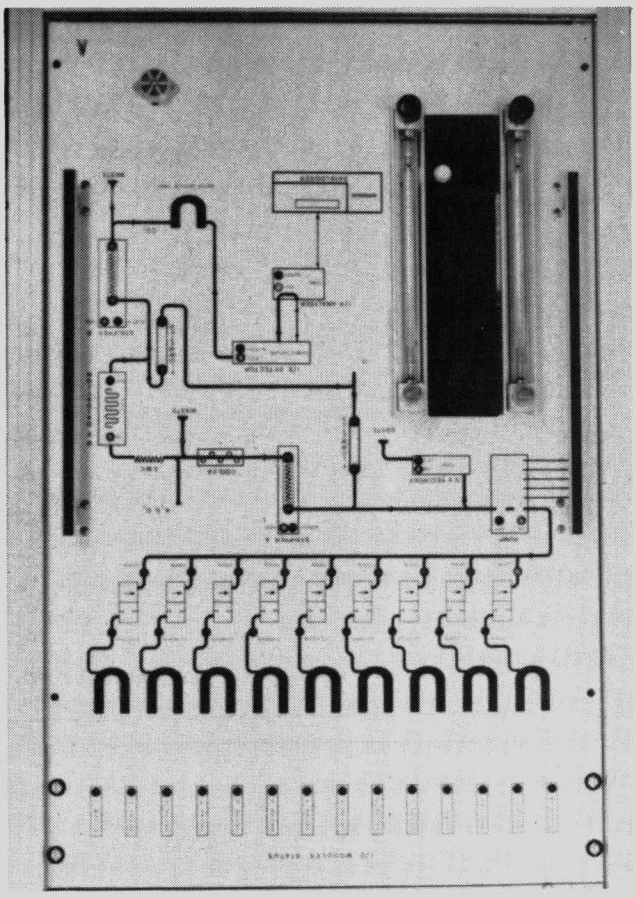
Data is obtained by direct read-out from a digital display and by a printer. Print-outs are obtained as a single average concentration of readings taken every 6 s over a required time of 3 to 10 min or as a graphic display. The RF10 incorporates a multi-channel sampling system.

Features include:

* Local manufacture.
* No costly and lengthy importation time.
* Capital investment less than 50 per cent of similar imported equipment.
* Continuous on-line monitoring, better effluent control.
* Immediate assessment of individual process behaviour at water treatment plants.
* Local service, maintenance and advisory services.

Performance characteristics

- ☐ Alpha numeric display on micro-computer prompts operator to select operation keys.
- ☐ LCD readings and print-out of DOC concentrations.
- ☐ DOC linear range 1 to 30 mg ℓ.
- ☐ Precision within 10%.
- ☐ LCD when system is ready to commence analyses.
- ☐ Multi-channel analyser.
- ☐ For one sampling source print-outs can be obtained for any time intervals.
- ☐ In multi-channel mode analyses are obtained every 16 min.
- ☐ Alarms, print-outs and visual display identifies system status.
- ☐ Exceeding concentration limit warnings.
- ☐ Loading and storage of programme by magnetic tape.



Functional characteristics

- ☐ Operating temperature > 10°C.
- ☐ Electrical supply 220 V AC.
- ☐ Oxygen flow rate 300 mℓ/min.
- ☐ Replacement of pump tubes every 7 days.
- ☐ Reagent volume 15 ℓ/week.
- ☐ Moisture removal from gas steam entering NDIR detector.
- ☐ UV oxidation source minimum lifespan of 5 000 h.
- ☐ Cl concentrations in water sample to be < 400 mg ℓ^{-1}.

For more information contact the National Institute for Water Research, CSIR, P O Box 395, Pretoria 0001. Tel: (012) 86-9211.