



S4 waterbulletin

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January/February 2002

GROUNDWATER

Dividing South Africa into groundwater regions

WATER QUALITY

Watering guidelines published for wildlife and rural communal livestock

WATER POLLUTION

Researchers investigate subsurface pollution from gold-mine dumps

00020041

INTRODUCTORY COURSE in WATER MICROBIOLOGY

Division of Water,
Environment and Forestry Technology
CSIR • Pretoria

21 - 24 May 2002

The Water Programme, Pretoria presents a course for people in the water industry who need to know more about the basic techniques used in the microbiological analysis of water. The course is recommended for industries, municipalities, government departments, water boards and water bottlers.

The course will be limited to a maximum of 10 participants to ensure personal attention. They will be trained in the basic concepts of health related water microbiology. The theoretical (theory 25% and lectures 15%) and the practical (60%) aspects to be covered will include:

- Detection and enumeration of indicators of pollution (heterotrophic plate count, total and faecal streptococci, coliphage and

the confirmation of *E. coli*.

- Demonstration of the detection of other pathogens in water (viruses, parasites and *Legionella*).
- Interpretation and reporting of results.
- Lectures on water purification and water disinfection, the importance of the chemical composition of water and their related health implications, the geology and hydrology of ground water.
- Quality control and laboratory safety.

A certificate of attendance will be issued on completion of the course.

Should you be interested, please contact:

Pauline Coubrough

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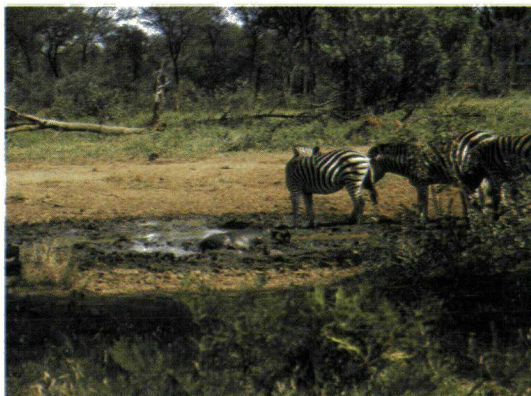
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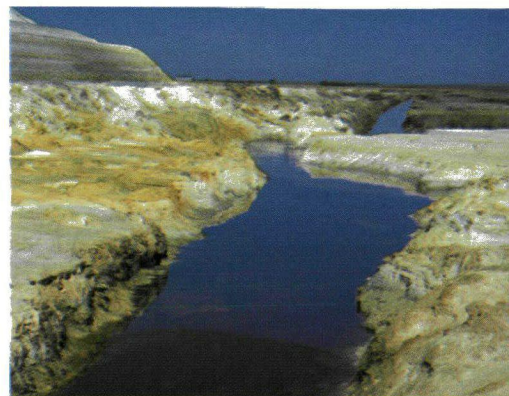




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Cover: A giraffe quenching his thirst in the Kruger National Park. (Photo: SA Waterbulletin)

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WRC re-organises research fields (and reshuffles management)

The Water Research Commission has regrouped its 17 research fields into five key strategic areas (KSAs) and four cross-cutting domains. Four of the five strategic research areas will deal with the various roles water plays, that is - water as a resource (addressing the management of water resources); water as a habitat (addressing water-linked ecosystems); the various water uses and waste management; and water in agriculture and forestry. The fifth strategic field

focuses on knowledge dissemination and management. The cross-cutting domains, a research domain shared across a number of key strategic areas, are Water and Society, Water and the Economy, Water and Health and Water and the Environment.

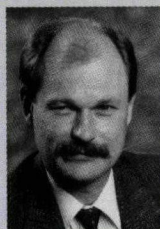
The managers appointed to the positions in the new WRC management structure are as follows:

KNOWLEDGE KSA



Director: Dr I Msibi

WATER KSA: SUSTAINABLE WATER UTILISATION FOR AGRICULTURE



Director: Dr G Backeberg



*Research Manager: Dr S Mkhize
(Head of the cross-cutting domain -
Water & Society)*

WATER KSA: WATER USE AND WASTE MANAGEMENT



*Director:
Mr J
Bhagwan*



*Research Manager:
Mr HM du Plessis
(Head of the cross-
cutting domain -
Water & the
Economy)*

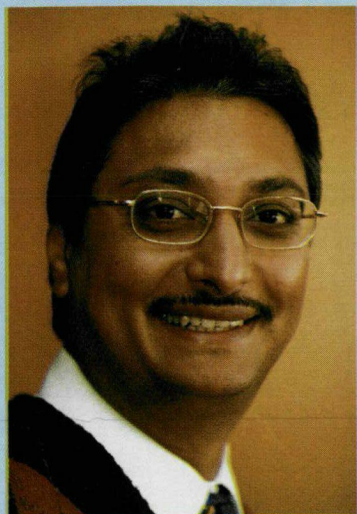


*Research
Manager:
Dr G Offringa*



*Research
Manager:
Mr G Steenveld*

New chairperson for WRC



Dr Hamanth Chotoo Kasan, General Manager: Scientific Services at Rand Water, has been appointed Chairman of the Water Research Commission Board with effect from 1 January 2002. He succeeds Professor Kingston Nyamapfene who decided to pursue other business interests overseas.

WATER KSA: WATER RESOURCE MANAGEMENT



Director: Dr N Mjoli



Research Manager: Mr H Maaren



**Research Manager: Mr K Pietersen
(Head of the cross-cutting domain
Water & the Environment)**

WATER KSA: WATER-LINKED ECOSYSTEMS



Director: Dr S Mitchell



**Research Manager: Ms A Oelofse
(Head of the cross-cutting domain -
Water & Health)**

ADMINISTRATION: FINANCE AND LOGISTICS



Director: Mr JA Venter

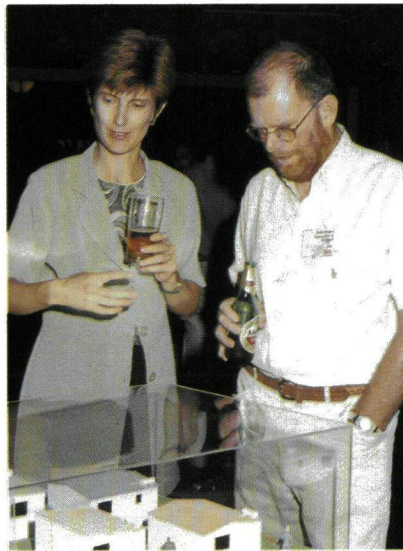
SA chapters launched of the Water & Sanitation Council and the Handpump Training Network

At the end of last year delegates gathered at the Misty Hills Country Hotel and Conference Centre, near Krugersdorp in Gauteng, to celebrate the launch of the South African chapters of the Water Supply and Sanitation Collaborative Council and the Hand Pump Technology Network.

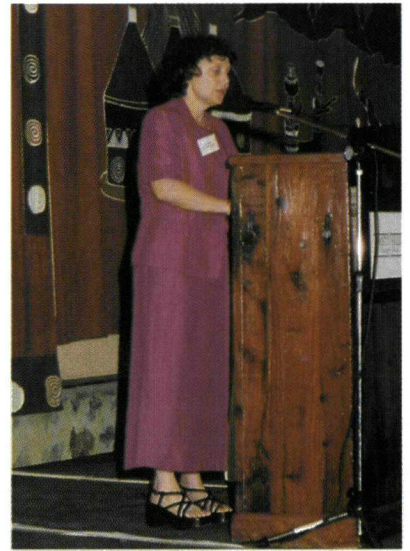
The launch formed part of a conference on appropriate technologies for sustainable water and sanitation services - an initiative by the Department of Water Affairs and Forestry in collaboration with the Department of Provincial and Local Government and the Water Research Commission.

In his keynote speech at the conference, the Executive Director of the Water Supply and Sanitation Collaborative Council (WSSCC), Mr Gourisankar Ghosh, said that in spite of the major achievements during the International Water and Sanitation Decade in the 1980s, "progress on sanitation has been lagging far behind water supply." He said, "There is still a common belief that water-borne sewerage is the appropriate means of sanitation and a wrong perception that Government will bear the cost of all expensive, water-bearing sewerage systems." In describing technologies that were appropriate to the local environment, Ghosh said that "sanitation has to be considered along with the design of water supply," and warned that "even in the case of handpumps, if the basic design does not include water disposal pits, it will create an unhealthy environment, and the 'safe' water supply in such an environment will not reduce the incidence of water-borne diseases."

Mr Ghosh told delegates that "elsewhere in the world, there is sadly a lack of understanding about health and hygiene issues and a lack of appreciation amongst all local governments for sanitation as a priority." With a tripling of government funds for sanitation in South Africa, he feared that the lack of capacity would pose serious problems in the future. "Strengthening of institutional capacity and knowledge networking are absolute musts," he said.



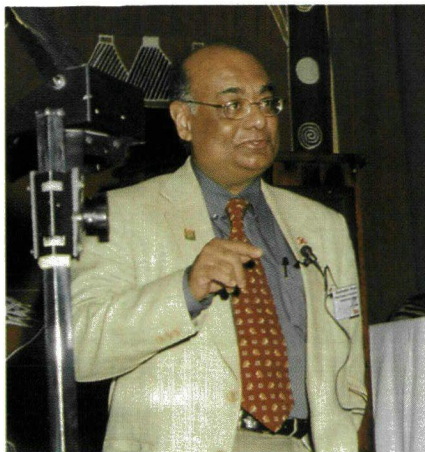
Ms Marna de Lange (International Water Management Institute) and Mr John Kings (Tsogang Water & Sanitation) discussing the absence of rainwater harvesting and other appropriate technologies in the exhibit.



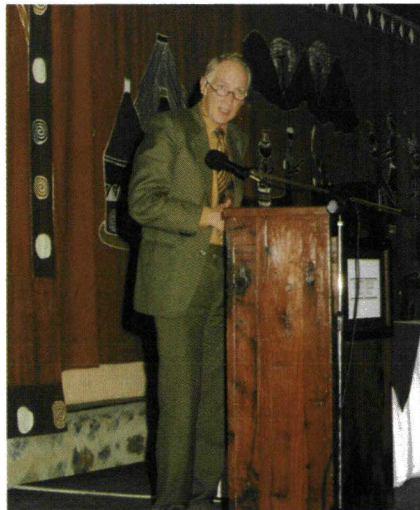
Dr Rivka Kfir (Chief Executive Officer of the Water Research Commission) welcoming delegates to the inauguration of the South African chapter of the Water Supply and Sanitation Collaborative Council.



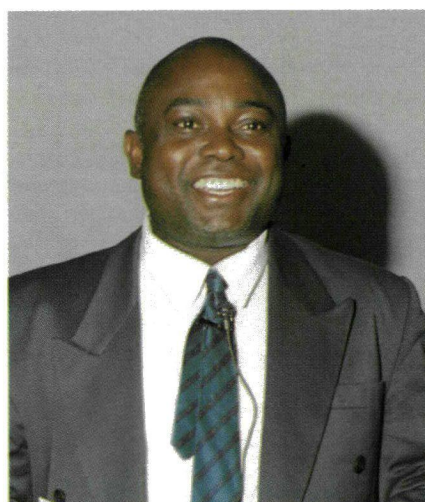
Mr Junior Potloane (Deputy Director-General: Regional Operations 2, Water Services, Department of Water Affairs & Forestry) and Dr Nozi Mjoli (Research Manager - Water Research Commission).



Mr Gourisankar Ghosh (Executive Director of the Water Supply and Sanitation Collaborative Council) delivering his keynote address at the Conference.



Mr Piers Cross (Water & Sanitation Programme - Africa, World Bank, Nairobi) addressing delegates.



Mr Boniface Aleobua (Deputy-Director - Geohydrology, Department of Water Affairs & Forestry, Pretoria).



Mr Jay Bhagwan (Research Manager - Water Research Commission) thanking the participants for their attendance at the launch of the WSSCC's SA chapter.

Ghosh described the role of the WSSCC as providing a transparent and inclusive platform for different players to openly and frankly exchange ideas and develop synergies towards a common cause. According to him, "the government, the community, the private sector, researchers and others are all equal and working towards the shared goal of Vision 21 - putting people at the centre of development initiatives." Vision 21, a WSSCC initiative, was presented at the 2nd World Water Forum in the Hague, last year. The essence of the Vision is to put people's initiative and capacity for self-reliance at the centre of planning and action.

Referring to the Summit for Sustainable Development later this year in Johannesburg, Mr Ghosh said the WSSCC is joining forces with the World Bank, the African Development Bank, the Water and Sanitation Programme and the UNCHS/Habitat to launch an African Sanitation 'movement' in 2002 which will include an African sanitation conference on the eve of the Johannesburg Summit.

Dr Rivka Kfir, Chief Executive Officer of the Water Research Commission, said at the launch that the WRC was honoured to serve as the initial coordinator of the South African chapter of the

WSSCC and "we hope that through the support of this local chapter, the activities of the Council in South Africa, the SADC region and the African continent will grow from strength to strength.

"The WRC identifies closely with the mission of the Council and its *modus operandi*. Accelerating the achievement of water, sanitation and waste management services to all people with special attention to the un-served poor has been the focus of many water-centered research and development projects carried out with the support of the WRC. Since 1994, the research that the WRC has supported in the field of water supply and sanitation has been largely in response to the needs of institutions that are responsible for ensuring that millions of South Africans who lacked access to these basic services are served. The products of these studies are addressing the needs of policy makers, local government institutions, water boards and community development agencies."

Launching the South African chapter of the Handpump Training Network (SAHTN), Dr Kfir said the international handpump training network had over the years provided an excellent knowledge network for handpump technology development and sustainability.

"The recent link between the WSSCC and Handpump Training Network will benefit the cause of the unserved. It is good to note that this partnership will increase the reach and improve effectiveness of the Network, particularly in the Africa region."

She said South Africa was at a stage where the technology would play a prominent role in providing water services to the poor. "A recent WRC study on handpumps estimated that there could be at least in excess of 10 000 handpumps in existence in South Africa, serving 2 million people or around 10 per cent of the population. The investment cost is about R 400 million and if one considers that about 50 per cent of these pumps are not working, this is a huge loss.

"It is therefore important for the SAHTN to provide the impetus and knowledge sharing that will make the handpump technology an acceptable and reliable technical option for communities."

Planning for the World Summit on Sustainable Development 2002

The Water Institute of Southern Africa (WISA) organised a forum meeting on 21 November 2001 at the Sandton Convention Centre in Johannesburg to inform representatives from the water sector about the significance and the preparations being made for the World Summit on Sustainable Development, which will be held in Johannesburg from 26 August to 4 September 2002.

The Summit, which promises to be one of the largest and most important international meetings ever held on the integration of economic, environmental and social development, will focus on poverty eradication, environmental health, financing mechanisms for sustainable development, technology transfer, trade and the environment, access to energy, air and atmosphere and land degradation. One priority issue for southern and South Africa is that of water.

In 1992, at the Rio Earth Summit, international consensus was achieved on the principles that should guide future water use and management. A document called Agenda 21 outlined the principle of integrated water resources management to ensure the co-ordinated development and management of water, land and related resources, by maximising economic and social welfare without compromising the sustainability of vital ecosystems.

The Minister of Water Affairs and Forestry, Mr. Ronnie Kasrils, in his address at the forum said that as host country for the Summit, South Africa has the opportunity to showcase its experiences in taking steps towards

sustainable development since the signing of Agenda 21 in 1992.

"We must utilise this opportunity to draw attention to problems that we share in common with all developing countries. We can further demonstrate success stories, as well as those projects where a Western approach has not provided the most appropriate solutions. Most of all, South Africa can show how within the developing context, and facing massive backlogs of under-served communities across widespread rural areas, we have managed to reduce the deficit of people without access to safe water by more than 50 per cent since 1994. This is in line with the Millennium target of 2015, which aims to halve the number of people without access to safe water."

The Minister said the South Africa position for the Summit would be within the context of other national and regional strategies.

"The New Programme for African Development (NPAD) recognises the essential requirement for water in the welfare and productivity of society and to African recovery. In addition, the National Rural Development Strategy (NRDS) aims at poverty alleviation in key rural areas where available resources, including water, must be mobilised and utilised for development. Any position that South Africa may take will clearly also reflect the main elements of these strategies which give a solid basis for South Africa's development priorities and goals."

The Minister said the government had made significant progress in develop-

ing policies which create the framework for sustainable development.

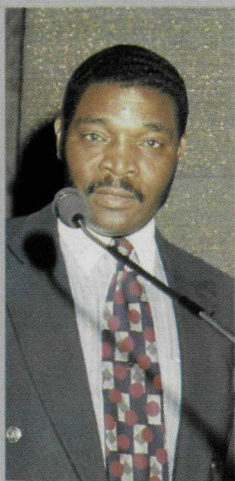
"We have a pioneering law that addresses the social, environmental and economic elements of sustainable utilisation of water resources, and we are in the process of implementing this law.

"Our initial work focussed on the systems and methodologies necessary to measure the sustainability, to define the limits of impacts and the criteria on which we would base our resource protection requirements. We are now applying these methodologies and basing management decisions on sustainability criteria in a transparent way that is both legally and scientifically defensible.

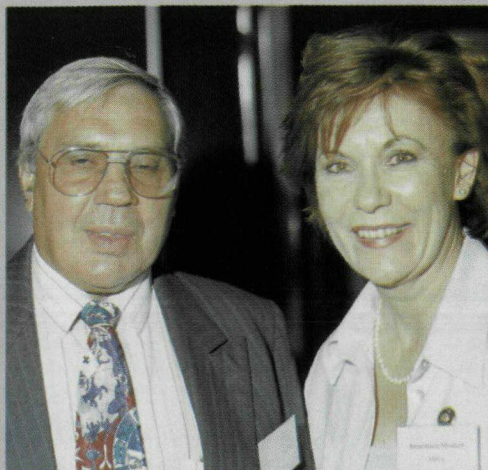
He said the Department was also applying these criteria to their own projects. A primary area was in the development of the country's large State dams, which was now based on a sustainability plan that integrates the environmental, social and economic elements through consultation with local stakeholders, to find the optimal approach to unlock the full resource potential of the dam.

Referring to the private sector, the Minister pointed out that sustainability was not the responsibility of the government alone.

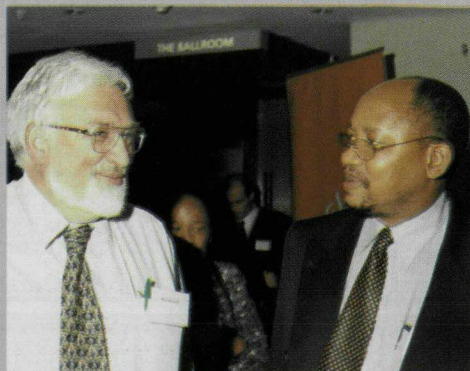
"Our legislative framework and the national and provincial programmes of government are the cue to the private sector to follow our lead. I urge you to explore all opportunities for partnerships in sustainable development of water resources - not least of which through providing essential services to people on a sustainable basis," he said.



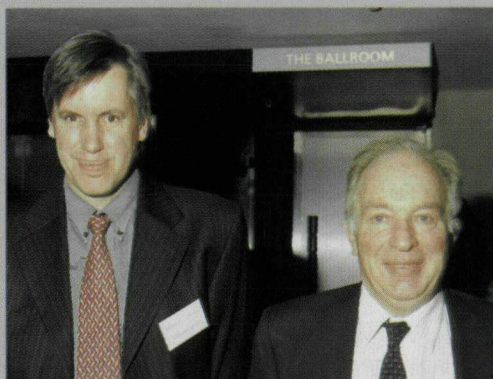
Joe Diescho
(Johannesburg
World Summit
Company).



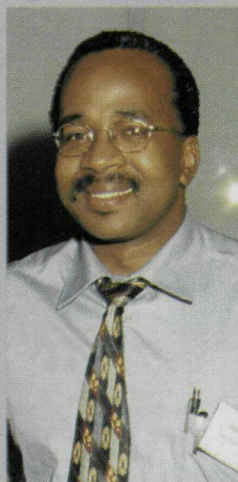
Hennie Venter (NGO) and Annemarie Mostert
(ABSA).



Willem Scott (NGO) and Thuso Ramaema
(WSSA).



Francis Gibbons (Stewart Scott) and Tony
Pitman (Johannesburg Water).



Danisa Zulu
(Bergman Ingerop)



Sandy Lebeso (Rand Water) and J Tsunke
(Mayor of Emfuleni).



Elaine van der Linde (DWAf), Jurgo van Wyk (DWAf), Pieter Viljoen
(DWAf) and Derek Vorster (Mhlathuse Water).



Vanida Govender (Eskom) and Danny
Vengedasamy (SACOB & ICC).

Looking at groundwater development in South Africa and how to divide the country into groundwater regions

Following a workshop in March 1991 on hydrogeological mapping and the development of a national mapping strategy, the Water Research Commission entered into an agreement with Mr JR Vegter, a hydrogeological consultant, to compile a hydrogeological map of South Africa. This assignment was completed by October 1995 with the publication of a set of seven maps depicting borehole prospects, saturated interstices, depth of groundwater level, mean annual groundwater recharge, groundwater component of river flow, groundwater quality and hydrochemical types.

However, by their very nature, hydrogeological maps are only able to portray a limited amount of groundwater information. A detailed reference work on the occurrence, availability and quality of groundwater was needed to enhance

the value of the hydrogeological map series. Accordingly, in terms of a renewed contract between the Water Research Commission and the author, Mr Vegter, work on the compilation of a monograph on South Africa's groundwater resources, that had earlier been suspended, was resumed in 1995.

This introductory report by JR Vegter not only deals with the subdivision of South Africa into groundwater regions, but also reviews developments in the field of groundwater in South Africa over the past 120 years.

This document is to be followed by a series of reports dealing separately with each groundwater region. The first two regional reports have already been completed and have been published simultaneously. Reports on several other regions are pending.

Part A of the report comprises of a historical overview from the introduction of the first drill in 1880 - a manually powered diamond rig used in the Cape Colony - up to the present. The following topics are covered - groundwater exploration and exploitation; investigation and research; and the evolution of groundwater legislation; as well as the current status of investigational methods and techniques and training in the groundwater field.

Vegter says factual information about water drilling by the private sector is virtually non-existent. Progress had to be gauged from records of drilling by State organisations. In 1950 there were, according to an agricultural census 152 000 water-yielding holes in existence on South African farms. Of this

number about 24 000, that is 16 per cent, may be attributed to state drilling operations. During the second half of the century and, particularly over the past two decades, the contribution by State-owned machines declined. Presently, it amounts to not more than one per cent (contract drilling for the State excluded).

The rate at which boreholes for water have been drilled by the private sector and the State increased from about 1 500 in 1896 (only in the Cape of Good Hope and Orange Free State) to about 100 000 at the turn of the 20th century. In the fifties the estimated rate was about 12 500 holes per annum. In the middle eighties it rose to about 56 000. These figures are rough estimates. They, nevertheless, seem reasonable in the sense that they correspond to a

mean growth rate of approximately four per cent per annum.

Several investigators have estimated groundwater use as follows:

1950	684 million m ³
1960	1 062 million m ³
1965	859 million m ³
1970	1 128 m ³
1980	1 790 m ³
1999	3 360 - 3 500 m ³

According to the 1980 estimate 78 per cent of the use of groundwater was for irrigation.

CRITERIA

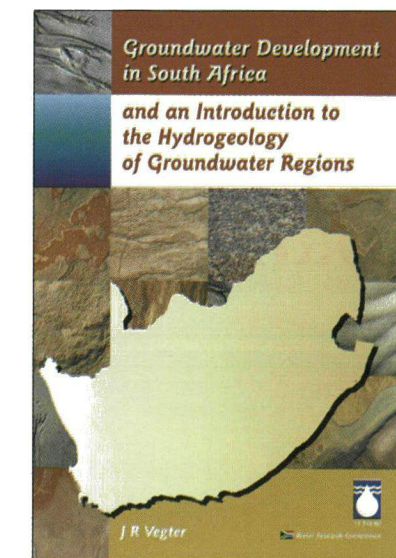
Part B of the publication deals with the criteria for dividing South Africa into groundwater regions. The effective

description of groundwater occurrence in a large geologically complex area such as South Africa requires the division and delineation of sub-areas that have uniform occurrence characteristics. This does not imply subdivision into hydraulic or hydrological units.

Fundamental to groundwater hydrology is the concept of interstices - the open spaces that form receptacles and conduits for groundwater, their origin, shape and interconnection. The types and origins of openings, therefore, may be considered to be a basis for the delineation of sub-areas.

From the water-bearing point of view, geological formations may be divided into two groups - those that are water bearing as a result of primary openings or of secondary openings.

Primary openings or pores originate contemporaneously with genesis of the sedimentary formation and igneous rocks in which they occur. Primary openings in igneous and metamorphic rocks are generally of no consequence in groundwater hydrology, owing to their minute size and lack of interconnection. During the lithification of sediments, primary openings are reduced in size by the physical-chemical processes of con-



solidation, compaction, cementation and re-crystallisation. The degree of diagenesis and metamorphism determines to what extent a sedimentary rock retains primary porosity and permeability or is converted into solid (hard) rock.

Secondary openings originate from processes that affect rocks after they were formed. These processes are tectonic deformation, weathering and unloading by degradation of the land surface. Secondary openings are planar

where formed along joint, cleavage, bedding and fault planes. They also consist of pores in disintegrated and decomposed rock.

The occurrence and availability of groundwater at any locality is determined by -

- ☐ The storage and transmissive properties of the geological formation;
- ☐ The volume and frequency of recharge;
- ☐ The rate of groundwater movement to discharge points or areas;
- ☐ The rate of groundwater discharge as springs and effluent seepage in streams; and
- ☐ Loss through evapotranspiration.

More than ninety per cent of South Africa's area rocks are water-bearing by virtue of secondary openings, that is, water is obtained from weathered and fractured hard-rock formations ranging in age from Earliest Pre-Cambrian to Jurassic and comprising sedimentary, metamorphic, extrusive and intrusive igneous rocks. With this in mind, division of the country on the basis of primary and secondary water-bearing rock clearly will be ineffective.

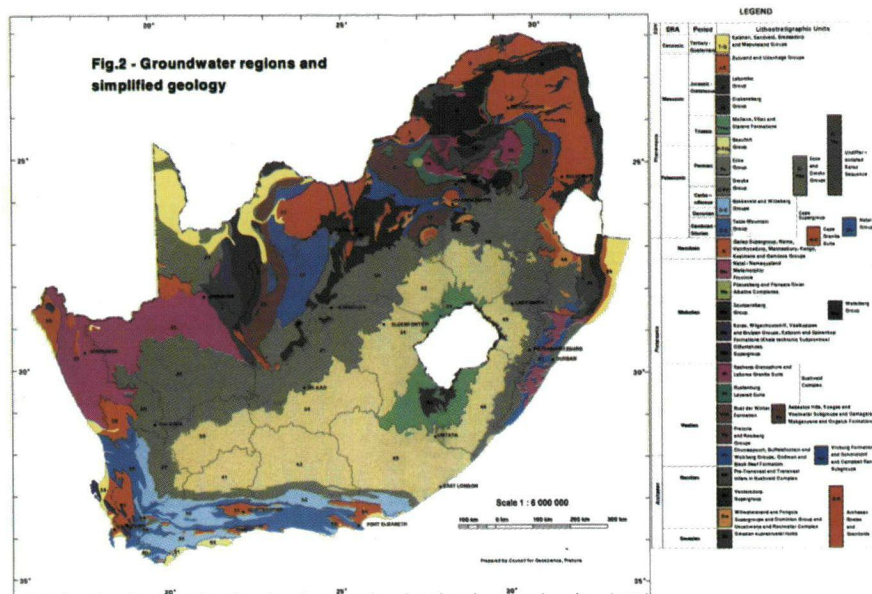
Because rock type and locally devel-



The effective description of the groundwater occurrence in a large geologically complex area such as South Africa requires division and delineation of sub-areas that have uniform occurrence characteristics.

oped structural and other characteristics govern, to a certain extent, the water-bearing properties, lithostratigraphic subdivision may well serve as a primary basis for subdividing South Africa into groundwater regions. A lithostratigraphic unit is one which is unified by consisting dominantly of a certain rock type or a characteristic combination of rock types or by possessing other significant unifying lithological features - distinctive colour, primary structures, etc. Other factors that were considered together with the lithostratigraphy aspect include physiography and climate, trying at the same time, not to end up with an unmanageable number of regions. A unique choice is obviously not possible.

It is important to note that the proposed subdivision is basically geological and not geohydrological. The regions are not hydraulic units. Delineation of hydrological units requires the establishment of groundwater divides and flow paths.



A map of the groundwater regions of South Africa prepared by Vegter (1995). Most of the country's groundwater is found in weathered and fractured hard-rock formations.

Copies of this report entitled **Groundwater development in South Africa and an introduction to the hydrogeology of groundwater regions** (WRC report TT 134/00) are available free of charge (in South Africa) from the Water Research Commission, Private Bag X03, Gezina 0031. (Overseas price US\$ 25, via surface mail).

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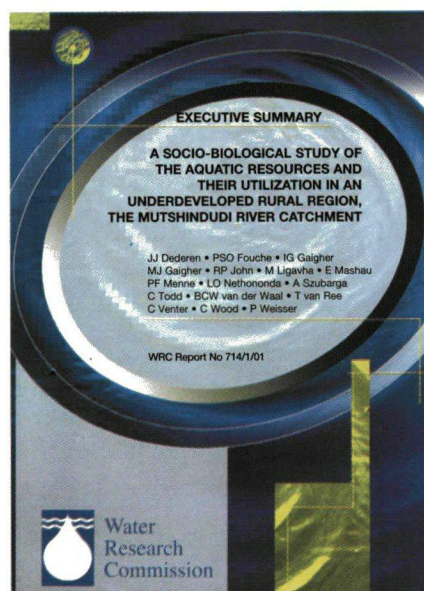
Aquatic resources studied in the underdeveloped Mutshindudi River catchment

With the initiation of the government's Reconstruction and Development Programme it became apparent that the underdeveloped rural regions of South Africa require more attention, not only to alleviate serious socio-economic problems, but also, as part of this process, to improve the condition of the environment.

This is said in report, published by the Water Research Commission, on a socio-biological study of the aquatic resources, and their utilisation, in an underdeveloped rural region in the Northern Province. The report, compiled by a multi-disciplinary team of researchers at the University of Venda in Thohoyandou, says that due to poverty and the dependence of a growing human population on natural resources, the aquatic environment has been seriously degraded in some rural areas.

"Standard management models for developed regions are unsuitable for underdeveloped rural areas due to a general lack of infrastructure, the traditional land tenure system and difficulties in enforcing legislation. These regions are also unique in various aspects such as the cultural importance of aquatic sites, the preference to use unpurified surface water for domestic purposes and the dependence on natural riparian

vegetation for food, energy, medicinal purposes, shelter, etc."



According to the report a need therefore exists for appropriate water management policies for underdeveloped rural areas and also for local expertise to assist in implementing these policies.

The report comprises two volumes and a summary volume. Volume 1 includes a general description of the Mutshindudi catchment, a socio-economic study of

the inhabitants, a sociological survey of the needs and problems of the existing water reticulation network, the utilisation of riparian plants, agricultural water demand, the cultural importance of water, the importance of fish as a resource and the importance of multi-disciplinary research in programmes of this nature. Volume 2 includes a chemical profile of the river, an investigation into pathogenic microbial contamination, the structure and composition of plant communities in the catchment, fish as indicators of water quality and the avifauna as indicator species for ecological integrity.

The research team consisted of researchers from the departments of Agriculture, Anthropology, Botany, Biology, Chemistry, Statistics, Sociology and Zoology at the University of Venda and the project comprised eleven independent but interrelated sub-projects. The researchers were JJ Dederen, PSO Fouche, IG Gaigher, MJ Gaigher, RP John, M Ligavha, E Mashau, PF Menne, LO Nethononda, A Szubarga, C Todd, BCW van der Waal, T van Ree, C Venter, C Wood and P Weisser.

MUTSHINDUDI RIVER CATCHMENT

The Mutshindudi River catchment in the Northern Province was chosen for the study as it is relatively small but has a

diversity of climatic and socio-economic conditions and problems typical of underdeveloped rural regions, and it is closely situated to the University of Venda.

The Mutshindudi River system lies in the Soutpansberg mountains north of the town Thohoyandou. It drains a part of the former Venda homeland. The river originates in the Entabeni State Forest and flows some 50 km in a north-easterly direction, before joining the Levuvhu River. The river has two main tributaries from the north namely the Tshinane and the Mbwedi.

The upper reaches of the catchment is situated in one of the highest rainfall areas in South Africa, however, the rainfall drops with altitude towards the confluence with the Levuvhu River. The high rainfall in the upper reaches of the Mutshindudi is reflected in a high and perennial flow rate.

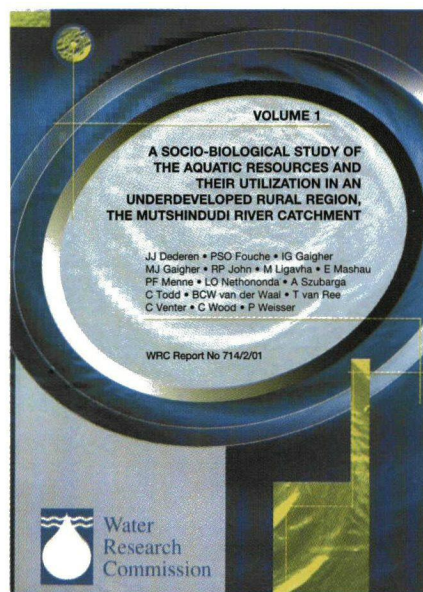
Vegetation in the upper reaches consists of montane forest and montane grassland with riparian forest along the river courses. The lower part of the catchment is vegetated by woodland or woodland with narrow strips of forest in the riparian zone. Most of the natural vegetation in the middle and lower reaches of the catchment has been removed for exotic afforestation, tea plantations or cultivation of annual crops. Indigenous forest still exist between Entabeni State Forest and the Thathe Vondo Dam, otherwise natural forest is found remaining in small patches only.

Two large impoundments have been built in the Mutshindudi catchment. The Thathe Vondo Dam with a capacity of 30.5 million m³ mainly supplies the Thohoyandou TLC (population 400 000) with water for household purposes. The Damani Dam with a capacity of about 13 million m³ provides water mainly for the Damani Coffee Estate. Several smaller impoundments and weirs also exist.

The middle and lower reaches of the catchment is densely populated and there are approximately 20 villages scattered throughout the area. According to the report land-use planning is unfortunately not based on economic principles. Due to an increase in population and general overstocking, the environment is rapidly deteriorating. Most farming activities are a form of subsistence farming.

SOCIO-ECONOMIC SURVEY

Unsustainable rates of resource consumption have an increasingly negative impact on the natural environment which in turn threatens human survival. Consequently it is imperative that a socio-economic profile of the inhabitants of the Mutshindudi catchment area is provided as part of an interdisciplinary study attempting to provide a model for the sustainable use of water in this area.



The survey presented the following profile:

- ☐ The inhabitants of the Mutshindudi area are for the most part very poor, with 74 per cent living on an income of less than R500 per month.
- ☐ The general educational level is also exceptionally low. Furthermore, women in particular have little say in the decision-making process in the community affairs of the villages.
- ☐ The infrastructure in the region is poor, with roads in an unrepaired state, electricity and telephone services in short supply, health clinics are understaffed and under supplied.
- ☐ Although most of the inhabitants do have access to piped water, the water provision is unreliable. Water from the river is often used for drinking purposes without any treatment to purify it.
- ☐ The prevalence of water-borne diseases is lower than expected, despite the fact that the river is used extensively for bathing and laundry. The incidence of bilharzia, however, is of concern.

- ☐ A general lack of proper sanitation poses a health hazard, while lack of waste removal is a decided cause for concern as well.

Recommendations are made within this context throughout the report.

WATER RETICULATION

Water reticulation in the Mutshindudi catchment consists of urban reticulation and rural systems. The water supply systems in the villages studied entail yard connections, standpipes, and boreholes served by diesel engines and handpumps.

The study concentrated on the villages and the results showed that almost all the villages in the Mutshindudi area experience problems with their existing water reticulation systems.

Some of the major findings were as follows:

- ☐ villages often obtain water from unreliable sources;
- ☐ fair and equitable sharing of available water in the catchment area is complicated by discrepancies in the reticulation systems installed;
- ☐ the existing reticulation network does not provide for an increase in demand; and
- ☐ the existing network does not meet RDP requirements.

There is also a lack of knowledge regarding the workings of the reticulation network or systems concerned. This makes it difficult for some people to understand the technical issues surrounding the problematic flow of water to and from various parts of their villages. The lack of knowledge makes people believe that the very same technical issues can be manipulated to give water to some villages and not to others.

The reticulation systems must be well understood by those benefitting from it. According to the report broad participation and an effective education campaign in water management and water service is needed. This will serve to improve the acceptance of the network with its inherent deficiencies. And immediately trigger a need to seek solutions based on and in response to the limited resources available.

Furthermore there is a lack of necessary structures to co-ordinate knowledge dis-

semination in the villages. Although there is an emergence of structures such as water committees, they seem to be structures accompanying the dawn of democratic practices without having a well conceptualised strategy to tackle the problems related to water delivery.

RIPARIAN VEGETATION

The evaluation of the status of the riparian vegetation showed that this important resource is generally severely over-utilised or removed for crop production in the river reaches below the Thathe Vondo Dam. Some 31 species of riparian plants are commonly used for firewood, fence construction and medicinal purposes, while the wild fruits are enjoyed by the children.

It is reported that community members expressed their concern about the over-utilisation and that they are aware of the fact that such over-utilisation causes a deterioration of the water quality. This is encouraging and would indicate that the population will be receptive for environmental conservation education and awareness programmes. Villagers also indicated that negotiation between villagers and the authorities on land allocation for gardens and fields will help to alleviate the problem.

FISH AS A RESOURCE

Fish is generally not considered to be an important resource in small rivers and the possible benefits to local communities are consequently ignored in planning and management.

However, the researchers say an earlier study on the use of grasshoppers in the Venda region brought the 'hidden' home consumption value of this neglected protein source into focus. Fish may play a similar role as grasshoppers in providing a valuable resource in the form of protein and recreation to the local rural population.

The research revealed that fishing in the Mutshindudi catchment is mainly done

for subsistence purposes. The major reason for fishing is the collection of fresh protein which is eaten as a relish with the main staple of maize porridge. Only about eight per cent of fishing activity was accounted for as recreation.

Nine different fishing methods were recorded, all of which seemed to be efficient and not requiring a high input in terms of capital as discussed in the report. Some 18 species of fish have been recorded, of which the banded tilapia (*Tilapia sparrmanii*), Mozambique tilapia (*Oreochromis mossambicus*) and redbreast tilapia (*T. rendalli*), as well as three species of small barbs (*Barbus spp*) are the most important.

The research indicated that the fish life of the river itself is presently harvested optimally, with some signs of overexploitation. This will necessitate future conservation measures.

AGRICULTURAL WATER USE

The most common agricultural activities in the Mutshindudi River catchment are traditional cattle farming, irrigated estates and schemes, rain-fed orchards and fields, as well as irrigated informal vegetable gardens. The informal gardens are prominent along the banks of the river and its tributaries.

The study showed that significant quantities of water (approximately 25 per cent of the mean annual runoff) are extracted from the river system annually for agricultural purposes. All the irrigable areas have not been utilised yet, so the agricultural water demand can be expected to increase significantly in the near future. Proper investigation and planning is necessary to ensure equitable water distribution, the conservation of the river ecosystem and improved efficiency of water use.

WATER'S CULTURAL IMPORTANCE

Although Venda is an extremely rich area as far as the cultural, religious and

ritual use of water is concerned, research in this field was complicated and restricted by the sacred nature of the knowledge required. However, the researchers are of the opinion that "these cultural data could be used in a contemporary context of rural development as educational data in programmes and campaigns aimed at raising awareness on the importance of water resources and related environmental issues."

MULTI-DISCIPLINARY RESEARCH

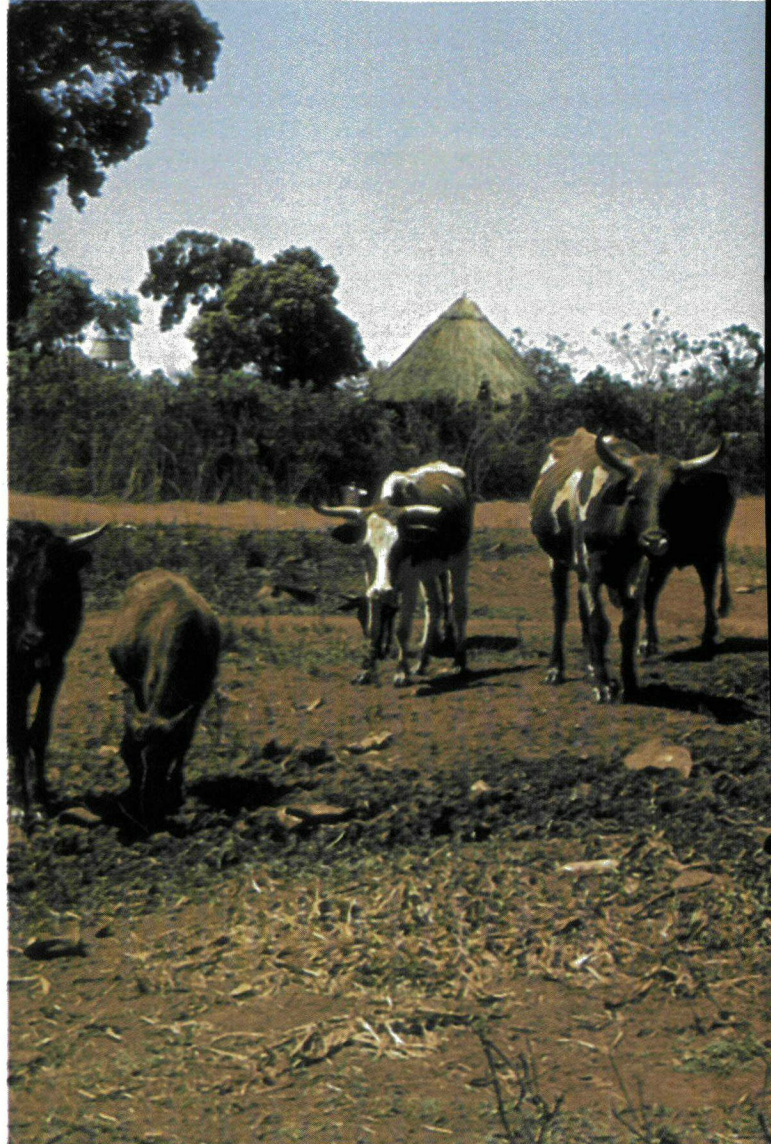
The sustainable utilisation of water resources in underdeveloped rural regions can only succeed if it is based on a knowledge of both environmental and human factors and if local communities are involved in decision making.

Environmental education is crucial, but in developing communities environmental education can only be relevant if it is presented as part and parcel of a broader development initiative. Such educational efforts, the researchers say, require the support of a multidisciplinary team of experts including both natural and social scientists. It must, however, also utilise inputs of indigenous knowledge if it is to be understood and implemented by the local community.

The researchers say that even with a committed and skilled group of researchers willing to participate in action research, it does not follow naturally that the community themselves will participate energetically. "People living in chronic poverty, with little education and even less self-esteem, cannot be expected to understand why their inputs in research programmes are necessary. It does, consequently, take time, patience and dedication to create a climate of mutual trust and co-operation." Making use of students as fieldworkers, as was the case in this study, is an effective method of breaking down barriers as the students originate from these communities and understand the culture and circumstances.

Copies of the reports entitled **A socio-biological study of the aquatic resources and their utilisation in an underdeveloped rural region, the Mutshindudi River catchment** (WRC report 714/1/01) are available free of charge (in South Africa) from the Water Research Commission, Private Bag X03, Gezina 0031. (Overseas price: Volume 1 - US\$ 20; Volume 2 - US\$ 25; and the Executive Summary - US\$ 10; all prices via surface mail).

Rural communal livestock and wildlife watering guidelines published



Many rural communities share a close association with livestock and sub

The results of the third Water Research Commission (WRC) project addressing water quality guidelines for animals has been published in the form of a final report. The report presents risk assessment modelling for three new user groups, namely, rural communal livestock production systems, wildlife and poultry production systems. Titled "An extension to and further refinement of a water quality guideline index system for livestock watering" (Volume 1 & 2), the report was compiled by NH Casey, JA Meyer and CB Coetzee of the Department of Animal and Wildlife Sciences at the University of Pretoria.

The researchers say the growth and development of this research field has taken place over a number of years.

"An initial brief was obtained from the WRC in 1990 with the request to verify criteria for beef cattle utilising subterranean water sources along the north and north western border regions of South Africa. Other livestock types were subsequently included, and in the final report (WRC Report K3/301), the guidelines then in use were shown to be inadequate and result in inaccurate estimates of risk."

Through biological toxicological trials using sheep, cattle and poultry, it was shown how single value cut-off limits were poor indicators of risk under the majority of conditions, and often resulted in the limitation of efficient water utilisation. These trials indicated that animals could be exposed to highly toxic water quality constituents, far in excess of the

guideline ranges, for specific production periods (e.g. weaning to market weight), without incurring any adverse effects on growth, health or performance. It was also shown how the omission of palatability effects by the guidelines could lead to financial losses for the livestock producer.

COMPUTER PROGRAM

"In a second Water Research Commission project (K5/644) - through further biological experimentation, extensive regional trials and modelling, a computer software program was developed called CIRRA - an acronym for Constituent Ingestion Rate Risk Assessment."

CIRRA conducts site-specific risk assessment based on the modelling of



ation between animal and man was observed to be a limiting factor to the successful application of solutions generated by the computer program CIRRA for problematic water sources. Shared utilisation of water resources effectively prohibits the application of treatments to it, due to the potential for adverse effects in humans.

The effect of animal product quality on human health was an additional area of concern. An accumulation of constituents such as lead and cadmium in renal cortex tissue in intensive commercial systems do not present a significant consumer hazard, as concentrations and dilution within the urban diet effectively provide for sufficient safety. This does not hold true for the rural production systems.

The production phase in rural systems is seldom as short, or well defined, as in commercial systems. Exposure periods are therefore longer, with ingestion rates typically greater due to a number of associated risk factors - e.g. temperature, moisture percentage of ration. Secondly, and quantitatively more important, the nature of the diet differs in terms of input origin variability. Potentially hazardous constituents in the water may find their way into the diet of sensitive user groups, such as reproductively active women and children, through a number of routes. These may be direct through the water, indirect via food preparation and irrigation of subsistence crops, and indirectly via the consumption of animal products from animals exposed to the water source.

A number of other routes incorporating bioaccumulation and bioconcentration may also apply, such as the consumption of aquatic organisms and the practice of providing reverse-osmosis brine to livestock, which may find its way back into the human diet through the consumption of organs, eggs or milk. This may be at even greater levels than those occurring naturally in water, partly due to the increased concentration of hazardous constituents in the brine, as compared to raw feed water, and the active transport mechanisms that may increase the concentrations thereof in milk.

In the developing communities this project reports on, both for livestock and humans, dietary deficiencies in terms of quantity and quality are real challenges.

risk factors from water, animal, environmental and nutritional data, to generate both risk assessment and possible solution options. This is based on a constituent ingestion rate, in milligram/day/kilogram body weight, corrected for metabolic water. This represents a radical departure from existing, static, tabulated guidelines which are all independent of production system effects, nutrition, environmental and animal factors, and appear in the form of a milligram/litre guideline recommendation. CIRRA caters for beef and dairy cattle, goats, sheep, pigs and horses, in the commercial context.

Through the outputs of these two WRC projects, two guideline editions for livestock watering emerged for use by the Department of Water Affairs and

Forestry. These are, however, still largely generic guidelines. As they appear in a tabulated format, utilising a target water quality range concept, they fail to accommodate significant site-specific toxicokinetic and toxicodynamic factors, rendering their application to a conservative, at best generic, estimation of risk.

□ Rural communal livestock production systems

The rural communal livestock production system model presented in this report attempts to cater for the complex requirement of balancing risk and hazard identification in the realm of environmental toxicology, with the significant role of water quality in improving the health of animals and humans. During the rural area investigations the associ-



Results indicate that the majority of the water samples collected contain constituents that exceed both local and international recommended guidelines by large margins. Adverse effects will be associated with the ingestion of these water sources by wildlife.

The link between livestock production, animal product quality and human nutrition, when viewed in context of the additional risk factors in rural communal production systems, takes on a more central role to the modelling of water quality guidelines for the user group. The ramifications of retaining the focus of water quality guidelines for livestock on the health of livestock, and failing to account for norm of product quality, would be grossly negligent. There is much evidence of animal products which may contain potentially hazardous concentrations of constituents with clinically accepted toxicity risks for humans, without the animal presenting any clinical manifestations of a trace element disorder. A such livestock health may not be a sufficiently accurate measure of the fitness for use of consumption products.

A high incidence of specific water quality constituents present in the water at potentially hazardous concentrations was found for all communities. Most were typified by a localised, often isolated, association between the environment, water, animals and humans. The communities had a varied spectrum of

user groups, such as women, infants and children. The valuable, and at times essential role, played by livestock was evident for most communities. Most systems lacked the required infrastructure to allow for separate alleviator treatments formulated for livestock to be administered to the watering system.

Animal data regarding risk of an environmental toxicological nature, may be used to the benefit of identifying similar risks for humans. The localised geochemical factors shared by both animals and humans allow for some valuable information to be gained regarding the types of effects that may occur due, in varying degrees, to water quality.

GUIDELINES

The drinking water quality guidelines formulated by the World Health Organisation (WHO), the United States Environmental Protection Agency (USEPA) and the Department of Water Affairs and Forestry (DWAF), are primarily based on hazard identification from single constituent exposure toxicological studies. The outcomes of expo-

sure to multiple constituents, as found to occur in the areas investigated, are not described by local and international guidelines. Ameliorating effects may be negligible, partial, or complete.

With this, and many other areas of uncertainty, animal health studies can provide a valuable means of determining the risk present due to potentially hazardous water quality constituents with the incorporation of significant site-specific factors. Animal health studies can provide valuable guidance to community health based studies. They afford an opportunity to gather tissue samples, not readily available from humans, for histopathological examination and various assays, which may provide an indication of possible subchronic effects that may occur in humans.

Finally, the investigations indicate that potential problems are not isolated occurrences, but rather localised anomalies, which have an additional problem of creating the lack of a comparative norm, as a large number of animals and humans, tend to be affected. The order by which the recommended guidelines

are exceeded and the intrinsic high risk of the product system and related environment, suggest that the possible solution option within CIRRA be expanded further. The identification of points in the ingestion route between water quality and types of health effects where risk is increased, or decreased, is of great value to proposing solutions to reduce risk. In the modelling of the rural communal livestock production system, this aspect was taken into account in the setting up of different data capturing screens and in the design of the presentation of the evaluation results. Although perhaps too complex at first glance, once familiar, these screens offer a tool for identifying and testing outcomes based management decisions.

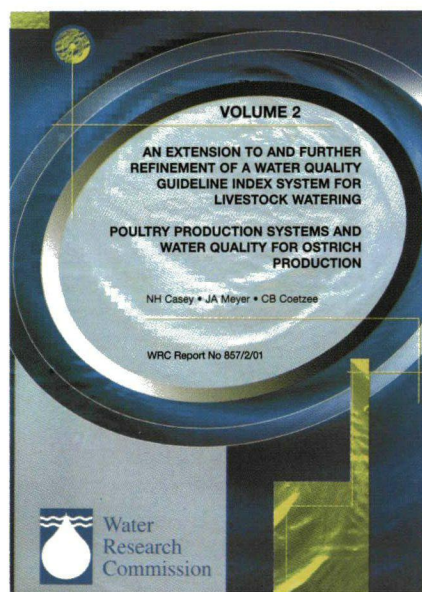
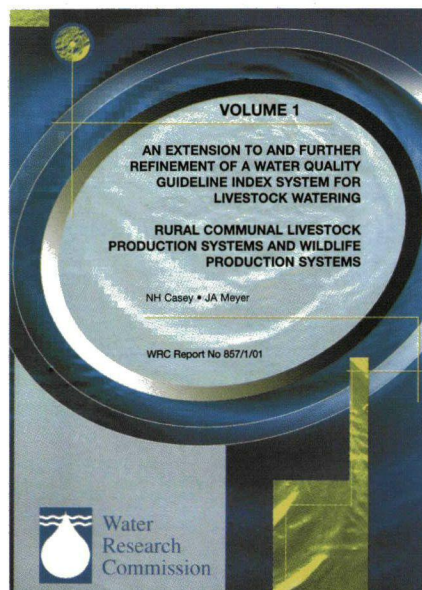
❑ Wildlife production systems

With the rapid increase in scientific investigations pertaining to game ranching, more game ranches are changing from an initial "untouched wilderness" concept to one that recognises the active-adaptive approach. There is an increased awareness relating to the profit-based business potential in game ranching. The ecological responsibility of providing water to game is also gaining recognition. The increased demand this places on management is accompanied by an increased requirement for specialist knowledge.

The effect of water quality on wildlife has typically received little attention. Most studies do not include chemical information on water quality, and when they do, it is usually inadequate and extended only to a handful of macro-element values. Studies elucidating the role of water quality constituents on issues such as reproductive health and immune responsive disorders are increasing, but the starting point of such studies requires knowledge of the quality of water, spatial and temporal, as a fundamental basis.

The water quality investigations presented in this report suggest that sufficient variability in water quality constituents exist in terms of palatability and toxicology to require management attention. The availability of multiple water sources and the presence of multiple wildlife species comprising different physiological stages makes risk assessment a fairly complex task. A software environment not only enables these complexities to be handled, but also guides the user as to the possible types of site-specific

information to be obtained. These information types will find application for game ranch management decisions other than those regarding water quality.



❑ Poultry production systems

Water quality constituents may impact on several norms, ranging from poultry health to equipment failure, all of which affect profitability. Apart from the obvious disadvantages to production from adverse effects on poultry health due to mineral imbalances, pathogens and parasites, knowledge of water quality is also required for managerial and nutritional purposes. For intensive commercial systems a constituent affecting nutri-

ent bioavailability or feed intake negatively, or increasing nutrient requirements for specific production defined parameters, can increase production cost.

For systems operating on large volumes and narrow feed margins, the contribution that water quality makes towards mineral requirements and significant dietary and drug interactions, must be taken into account for feed formulation to be accurate and representative of true requirements. A system incorporating those site-specific factors, influencing the adverse effects that may occur due to potentially hazardous constituents, allows for increased measurement and observation of these factors. The researchers say it is hoped that this will allow for more efficient usage of water, and also prevent the incorrect classification of water sources that pose a "potential" hazard based on rudimentary guidelines, and encourage water users to acknowledge water with a high mineral content as not simply water with poor quality, but rather as a potentially valuable source of minerals.

❑ Ostrich production

The occurrence of significant differences in mineral concentrations found and the consistency with which these differences occurred within treatment groups, indicates the need to incorporate the role of water chemistry and geochemistry in formulating the dietary requirements on a farm-specific basis. Prescribing a ration or nutritional programme for a district runs the risk of under or over-estimating the mineral requirements of ostriches. As a result, imbalances may precipitate deficiencies with consequent loss of productivity and - as appears to be the case in at least several of the farms - may even result in skeletal-related slaughter-process problems.

Copies of the report entitled **A water quality guideline index system for livestock watering - Volume 1: Rural communal livestock and wildlife production systems** (WRC report 857/1/01) and **Volume 2: Poultry and Ostrich production systems** (WRC report 857/2/01) are available free of charge (in South Africa) from the Water Research Commission, Private Bag X03, Gezina 0031. (Overseas price: Volume 1 US\$ 25 and Volume 2 US\$ 20, via surface mail).



Toe dams considerably reduce the immediate pollution potential of a tailings dam or a sand dump by collecting run-off and seepage water and retaining it for evaporation.

A study sponsored by the Water Research Commission has shown that substantial pollution occurs in the subsurface underlying former South African gold-mine dumps. Based on the findings of the study the researchers, however, say it is premature to quantify this impact and to incorporate it into a risk assessment approach. This investigation therefore provides a first step towards a risk assessment and serves mainly as a hazard assessment.

The study was carried out by the firm Pulles Howard & De Lange Inc for Geo-Hydro-Technologies (Pty) Ltd and the researchers involved were T Rösner, R Boer, R Reyneke, P Aucamp and J Vermaak.

Historically, South Africa has been the largest producer of gold in the world, an activity which resulted in large quantities of mine waste.

"In 1996, for instance, a total volume of 377 million tons of mine waste was produced, accounting for 81 per cent of the

total waste stream in South Africa. The presence of these mine waste resulted in large-scale pollution of the subsurface as they contain vast amounts of sulphide minerals, which give rise to the generation of acid mine drainage." Acid mine drainage originates primarily from the oxidation of sulphide minerals which occur in significant quantities (30 - 50 kg of sulphide minerals per ton) in the primary ore. The acid drainage emanating from the gold residue material in South Africa contains, as a rule, large quantities of salts (sulphate and chloride), significant concentrations of toxic heavy metals and trace elements such as copper and arsenic, as well as radio nuclides.

This poses a potential threat to the scarce water resources (surface and groundwater) of South Africa and is cause for serious concern with respect to land development sites, especially where tailings dams have been reclaimed.

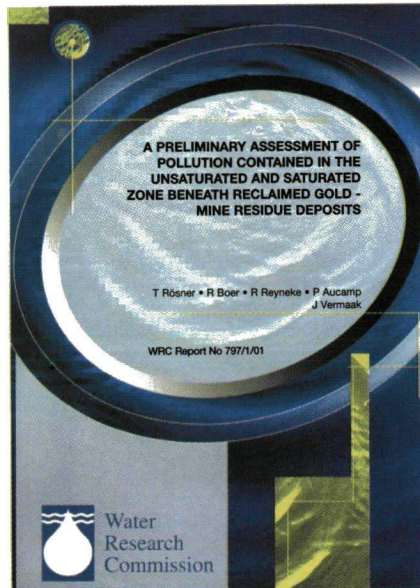
A number of tailings dams in the Gauteng Province are currently being

reclaimed and reprocessed to extract gold still present in economically viable concentrations in the tailings material. Once the tailings material has been removed, the land has a certain potential for land development. But it is important to take into account that the reclaimed tailings material leaves a contaminated footprint on the subsurface. The researchers say it is also important to understand that slight changes in the pH or other conditions of the soil (e.g. by land use or climate) can cause remobilisation of large amounts of contaminants, which are characterised by a geochemical behaviour that is time-delayed and non-linear. Additional field and laboratory testing would be obligatory for the in-depth understanding of the long-term dynamic aspects of these contaminant processes, which pose a serious threat to the vulnerable groundwater resources (i.e. dolomite aquifers) and land development.

RESULTS

The main findings of this investigation could be summarised as follows:

Groundwater quality beneath and in close vicinity to the investigated tailings dams is dominated by the calcium-magnesium-sulphate type, indicating acidic seepage, although all sites with relevant groundwater data (used in the study) are underlain by dolomitic rocks. In addition, high TDS (up to 8 000 mg/l) values occur mainly as a result of high salt loads (sulphates and chlorides) in the groundwater system. In most of the samples, groundwater pH values are fairly neutral due to the acid neutralisation capacity of the dolomitic rock aquifer. There is a tendency for groundwater quality to improve further down-gradient of the tailings dams as a result of dilution effects and precipitation reactions caused by the high acid neutralisation capacity of the dolomitic aquifer. These observations have been confirmed with the application of numerical groundwater models. However, groundwater quality in close proximity to the sites is often characterised by elevated trace element (e.g. arsenic, cadmium, cobalt, iron, manganese and nickel) and total carbon-nitrogen concentrations, exceeding drinking water standards in some boreholes.



Elevated trace element concentrations in the soils affected by acid mine drainage and the high mobility of phytotoxic elements such as cobalt and nickel complicate rehabilitation and recultivation attempts. The most commonly applied remediation method involves the addition of lime. However, where more than one trace

element is involved in the rehabilitation, changing the soil pH may reduce the mobility of some elements whilst remobilising others such as molybdenum (under alkaline conditions).

Preliminary tests indicate that the extractable trace element concentration of the selected reclaimed site shows greater exceedance ratios in the unsaturated zone and, furthermore, shows a variable spatial contaminant distribution. For example, uranium exceeds the threshold value (0.04 mg/l) by three orders of magnitude. Cobalt, nickel and zinc exceed their threshold concentrations of 0.5, 1 and 10 mg/l, respectively. Chromium and lead also exceed threshold values. Extractable arsenic concentrations, and occasionally lead and chromium, did not exceed the lower analytical detection limits.

The mobility of trace elements is dependent on a number of parameters, including pH. All the trace elements examined are most mobile when the soil pH is less than 4.5 and least mobile when the soil pH exceeds 6. Cobalt, nickel and zinc are the most mobile trace elements



Soils contaminated with toxic substances can have a direct influence on human health if houses are built and gardens are established on land affected by mine tailings.



Seepage emanating from tailings dams has a negative effect on water quality in nearby surface water systems.

for the selected reclaimed site. Chromium, copper, iron, lead and uranium are less mobile compared to the previous elements, indicating that a significant portion of the latter trace elements is contained in the residual fraction of the solid phase.

- The application of the geochemical load index for the assessment of the future pollution potential (worst-case scenario) for seven sites classified three sites as moderately to highly polluted (pollution class 3), three sites as highly polluted (pollution class 4) and one site as excessively polluted (pollution class 6). For comparison, pollution class 6, reflects a 100-fold exceedance above the background value.
- Soil conditions indicating preferential flow (bypass of the soil matrix) were

observed in some test pit profiles. However, the identification of dominant contaminant migration process would be premature owing to the lack of in-situ infiltration tests.

- The extractable concentrations of cobalt, chromium, copper, nickel and zinc found in gold-mine tailings samples exceed threshold concentrations. This confirms that gold-mine tailings are a source of trace element pollution. In addition, tailings dams continue to release significant salt loads contained in seepage for an extended time period after termination of mining operations. Seepage emanating from tailings dams also have a negative effect on water quality in nearby surface water systems, which impacts adversely on water users in those areas as a result. High sulphur concentrations are contained

in the leachate. Consequently, incomplete reclamation of tailings would result in tailings material remaining on the surface. Such material provides an additional reservoir for acid generating processes and contaminant release.

- International guidelines such as the soil quality standards of the Netherlands (Holland List) are not directly applicable to South African conditions. The predominantly humid climate conditions in Europe do not correspond with South African conditions in the areas where the bulk of mining activities take place. Major difficulties which occur when different studies are compared could be avoided through the use of standardised approaches to analytical testing (e.g. extraction tests) and the establishment of background or baseline values.

Copies of the report entitled **A preliminary assessment of pollution contained in the unsaturated and saturated zone beneath reclaimed gold-mine residue deposits** (WRC report 797/1/01) are available free of charge (in South Africa) from the Water Research Commission, Private Bag X03, Gezina 0031. (Overseas price: US\$ 25-00, via surface mail).

Hydrogeology of groundwater: Region 1 - The Makoppa Dome

The first region to be described in the Monograph on South Africa's Groundwater Resources, compiled by JR Vegter, is the Makoppa Dome.

The Makoppa Dome is situated north-west of Thabazimbi and comprises the northwestern corner of the Northern Province as well as a small portion of the adjoining Northwestern Province. The Marico River constitutes part of its northern boundary and the lower Crocodile River crosses the region in the east.

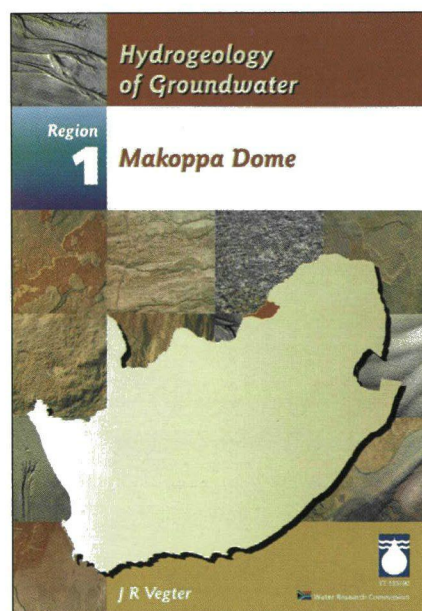
Region 1 is a bush-clad virtually level expanse except for some hilly ground in the extreme west and a few koppies in the east. By far the greater part is underlain by Swazian granite and granite-gneiss that contains scattered occurrences of Swazian metamorphosed metasediments and mafic intrusives. In the west there are two bodies of intrusive Gaborone Granite. Younger volcano-sedimentary formations fringe the region's southern boundary. Cainozoic detrital deposits and calcrete extensively cover the Swazian rocks. Average annual summer rainfall ranges between 475 and 600 mm.

Groundwater is being exploited on a large scale along the Crocodile River for irrigation. Informal settlements, small communities and farms are dependent on groundwater for human consumption, household use, stock and game watering.

Alluvium along the Crocodile River consists typically of sandy clay or clay overlying sand, gravel and boulders. Weathered bedrock is usually present. The combined saturated thickness of alluvium and weathered bedrock ranges between 20 and 40 m. In 1985 the yields of boreholes that were used for irrigation averaged 7.9 litres per second. This report is concerned with the occurrence of groundwater in the hard-rock formations. Borehole data of the

National Groundwater Database have been statistically analysed. Drilling success rates are as follows:

Swazian rocks	35.9%
Gaborone Granite	25.4%
Volcano-sedimentary formations	28.9%



To be regarded successful a borehole must yield at least 0.1 litres per second.

The occurrence of groundwater in hard-rock formations is determined by the extent of weathering and fracturing. Optimal strike depths are as follows:

Swazian rocks	30 - 85 m
Gaborone Granite	20 - 65 m
Volcano-sedimentary formations	35 - 55 m

Within these optimal strike zones the probability of striking water is still small. In the hope of striking water deeper down, unnecessary deep drilling has been undertaken in the past. It is more profitable to attempt a second borehole

once the maximum optimal depth is reached. With the exception of known steeply dipping fracture zones, where second attempts to strike the same water source shallower or deeper may be warranted, further drilling should not be undertaken in the immediate vicinity. There is no point in duplicating a borehole in basically the same formation. Water level depth plus a narrow optimal strike zone below water level should ideally determine drilling depth. This zone is generally 10 to 20 m thick.

Electrical depth probing and magnetic geophysical methods are indispensable tools in the siting of boreholes. Frequency domain electromagnetic techniques may also be employed to locate narrow linear conductive features such as fracture and fault zones. Geophysical work is generally guided by surface indications such as lineations on aerial photographs and satellite imagery, changes in soil and vegetation. To ensure optimal results, drilling, geological and geophysical borehole logging should go hand-in-hand. The most favourable orientation of structural elements may possibly be deduced from the orientation of the neotectonic strain ellipsoid. This has, however, not yet been proven in the Makoppa Dome region.

Copies of this report entitled **Region 1 - Makoppa Dome** (WRC report TT 135/00) compiled by JR Vegter, are available free of charge (in South Africa) from the Water Research Commission, Private Bag X03, Gezina 0031. (Overseas price: US\$ 20, via surface mail).

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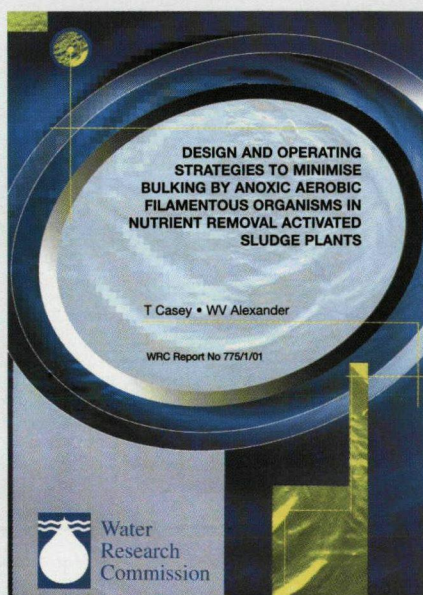
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Report 775/1/01 - Design and operating strategies to minimise bulking by anoxic aerobic filamentous organisms in nutrient removal activated sludge plants

Report to the Water Research Commission by Stewart Scott Consulting Engineers.

Authors: T Casey and WV Alexander
Overseas price: US\$ 10 (via surface mail)

The nitrification, denitrification, biological excess phosphorus removal system is given prime consideration whenever a new wastewater treatment plant is required in South Africa. This is a consequence of its ability to meet stringent nitrogen and phosphorus removal standards. However, experience with these types of treatment plants in South Africa and elsewhere in the world has brought to light a behavioural response in the activated sludge that has a significant effect on the design and operation of the system. The systems are prone to produce sludges that settle poorly in the clarifier (secondary settling tank) where the sludge and treated effluent are separated by gravity sedimentation settling.



The organisms in activated sludge can be categorised on the basis of their morphological characteristics, either as filamentous or floc-forming. The relative proportions of filamentous and floc-forming organisms largely determines the settleability of the sludge in the final stage of treatment, the clarifier. Absence of filamentous organisms gives rise to a sludge that settles rapidly but clarifies poorly, in that small sludge particles remain in the supernatant, a condition termed "pin-point floc" which results in loss of solids with the effluent. Presence of excessive filamentous organisms in sludge inhibits its settleability in the settling tank and it is referred to as bulking sludge. A bulking

sludge may result in gross sludge loss with the effluent - i.e. secondary settling tank failure - under normal design operating conditions. For optimum settling tank performance, filaments should be present in sufficient numbers such that their growth within the floc provides the floc with structure, thereby enhancing the sludge clarification characteristics, but the filaments should not proliferate to the extent that filament bridging between the flocs, with associated diffuse floc-formation, inhibits sludge settleability. The correct proportion of filaments and floc-formers produces a rapidly settling sludge that also clarifies the surrounding mixed liquor.

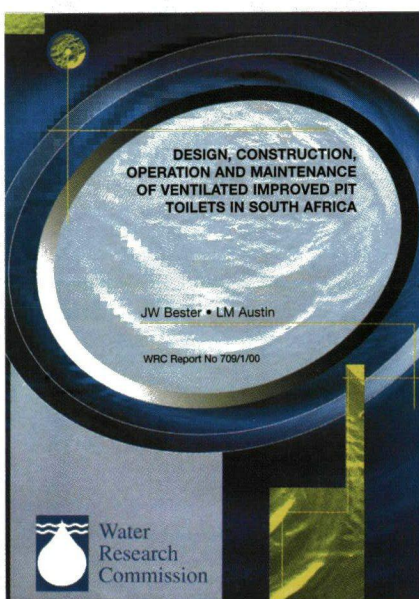
The objective of this research project was to test the principles of the Anoxic-Aerobic bulking hypothesis at large-scale activated sludge nutrient removal plants and develop criteria for their design and operation in order to minimise filament proliferation. The hypothesis was developed by the Water Research Group at the University of Cape Town. To date there has been some reluctance from scientists and engineers in the sanitary engineering profession to accept the hypothesis and apply its principles in the design and operation nutrient removal activated sludge plants. This is probably a consequence of the development and testing of the hypothesis in laboratory-scale activated sludge systems only. To this point the only supportive evidence for the hypothesis from large-scale plants has been anecdotal in nature. 

Report 709/1/00 - Design, construction, operation and maintenance of ventilated improved pit toilets in South Africa

Report to the Water Research Commission by the CSIR Building and Construction Technology.

Authors: JW Bester and LM Austin
Overseas price: US\$ 15 (via surface mail)

At present, ventilated improved pit (VIP) toilet systems installed in South Africa are constructed according to a wide variety of designs and with many different types of materials, with a corresponding diversity of performance level and user acceptability. Some designs are of a good standard, but many toilets have been installed which do not function properly and are therefore unpleasant to use. Fly control is often inadequate and factors such as poor construction, high temperatures



and bad odours can contribute to negative user experience and subsequent perceptions of the systems as second-rate or inferior.

The aim of this research project was to improve the standard of VIP toilets in South Africa by providing responsible

organisations with the necessary information to enable them to plan, design, construct and maintain VIP toilets in an effective and sustainable manner

The report includes a brief introduction to personal hygiene, which highlights the dangers inherent in human faeces and the importance of using toilets and of washing hands. The disease carrying role of flies is also pointed out. It is further emphasised that three integral factors, which must co-exist, are of importance in promoting community health, namely, safe water supplies, adequate sanitation facilities and the correct disposal of refuse.

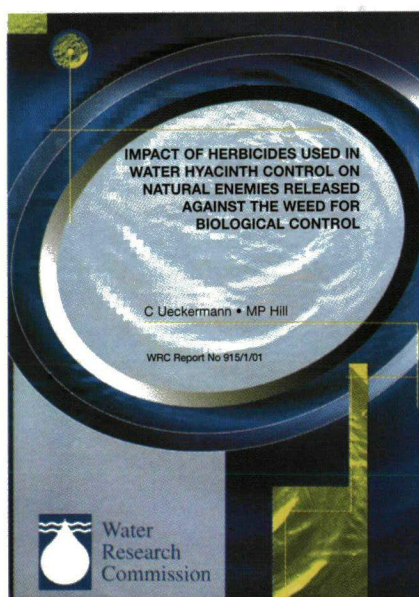
The operational principles of the VIP toilet are discussed in detail, covering important factors such as proper ventilation as well as fly and odour control. This is followed by a number of illustrated examples of VIP toilet designs from Botswana, Zimbabwe, Lesotho, Tanzania and Brazil, as well as various South African examples. The report also deals with the issue of contamination of groundwater, population density, maintenance and the emptying of the pit. 

Report 915/1/01 - Impact of herbicides used in water hyacinth control on natural enemies released against the weed for biological control

Report to the Water Research Commission by the Department of Botany (Ecology) at the University of Pretoria in conjunction with the Plant Protection Research Institute at the Agricultural Research Council.

Authors: C Ueckermann and MP Hill
Overseas price: US\$ 15 (via surface mail)

Water hyacinth is one of South Africa's



most damaging aquatic weeds. It is widely distributed throughout the country and mats of the weed impact all

aspects of water utilisation. Several control options are practised in South Africa, including large-scale herbicide control, limited mechanical control and manual removal, biological control and aspects of nutrient control. More recently, attempts have been made to try and integrate a number of the control methods to achieve the highest level of control. The integration of biological and herbicide control is currently the most widely advocated control method. However, this relies on the assumption that these two methods are compatible.

The report discusses the results of a research project aimed at testing the assumption that the herbicides used in water hyacinth control are not toxic to two arthropod species, the weevil *Neochetina eichhorniae* and the water hyacinth bug *Eccritotarsus catarinensis*, released as biological control agents for the weed in South Africa. 

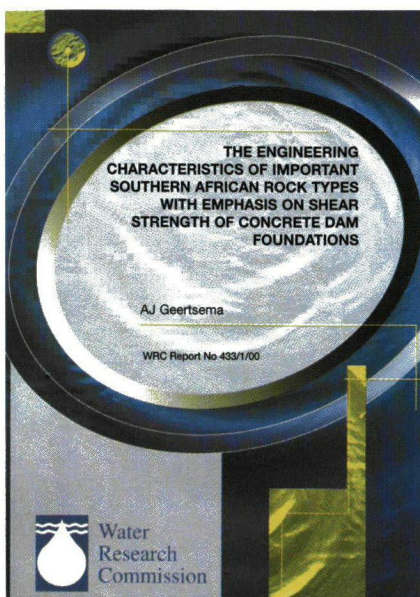
Report 433/1/00 - The engineering characteristics of important Southern African rock types with emphasis on shear strength of concrete dam foundations

Report to the Water Research Commission by the Department of Civil Engineering, Technikon, Pretoria.

Author: AJ Geertsema

Overseas price: US\$ 15 (via surface mail)

The stability of a dam depends on its design, on the materials and methods used during its construction and on the stability of the foundations on which it is built. The characteristics (or properties) of the rocks and particularly the shear resistance of the joints in the rocks are very important design parameters. The latter parameter has generally not received the necessary attention, mainly because it can not be determined quickly and cheaply. Also, obtaining representative rock samples is very difficult and often only the more competent materials survive the sam-



pling processes.

This report describes the strength, deformation and general characteristics of quartzite, shale, sandstone, dolerite, mudstone, granite, rhyolite and tillite. These rock types were selected because they cover a very large portion of the surface area of southern Africa, and as such many dams and other civil engineering structures have been built on them.

Emphasis was placed on the shear

strength parameters of joints, especially the angle of friction. Two types of joints are recognised in nature - joints with no or little fill material, where the shear strength is determined by the characteristics of the rock material and, secondly, joints with fill material where the shear strength is determined by the characteristics of the fill material. The major part of this research concentrated on joints with no or little fill material.

As part of the research project, a laser scanning device was developed and built in association with the Department of Civil Engineering of the University of Natal. This device measures x, y and z co-ordinates on a rock joint surface on a grid pattern. The information obtained can be analysed on a computer to produce a contour diagram of the joint surface area. From this contour diagram, joint roughness profiles are obtained which are important for the determining of the shear strength of joints.

This study provides a useful guide to engineering parameters of several important rock types for planning and preliminary design purposes. It is probably the most comprehensive document describing the rock material, the testing procedure and the engineering characteristics of so many rock types in Southern Africa. 

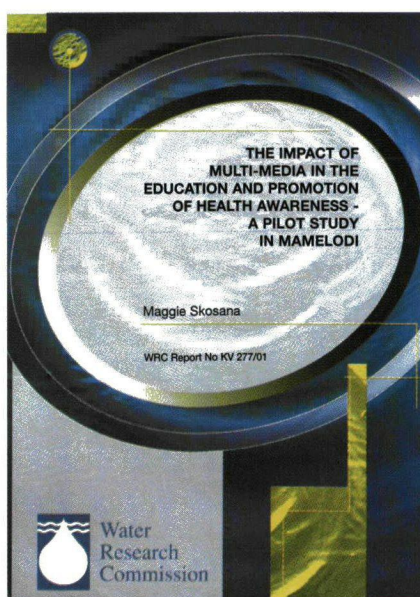
Report KV 227/01 - The impact of multi-media in the education and promotion of health awareness - a pilot study in Mamelodi

Report to the Water Research Commission by Skosana & Associates.

Author: Maggie Skosana

Overseas price: US\$ 10 (via surface mail)

A pilot study in Mamelodi (a township near Pretoria) was initiated to establish whether the messages of a multi-media edutainment vehicle such as Soul City had a long-term impact.



Questionnaires were administered to

384 households, at varying levels of socio-economic status, while men and women, individually and in groups were interviewed.

The report summarises the results of the study which confirmed the power of multi-media in the promotion of health and hygiene practices. The results further confirmed that the messages carried by the Soul City programmes need to be used in the specific, local context to give personal relevancy. The report recommends that a national initiative such as Soul City needs to be supported by localised health and hygiene programmes to ensure easy acceptability and retention. The health promotion programmes need not be costly - available resources could be used to maximise the benefits. This would involve graffiti, billboards, community radio stations and the existing clubs, or so-called "Burial Societies". 

Report 981/1/00 - Incorporation of water, sanitation, health and hygiene issues into Soul City, a multi-media edutainment vehicle

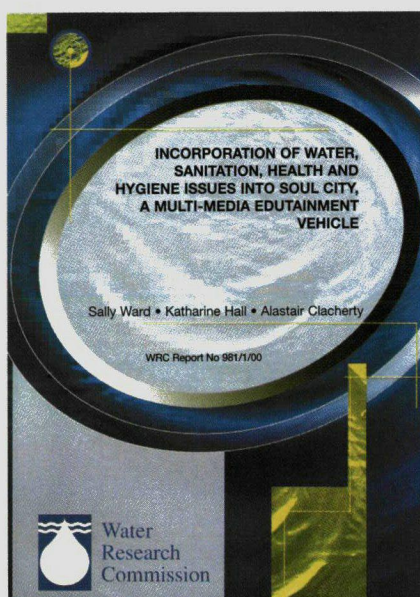
Report to the Water Research Commission by Soul City in conjunction with Clacherty & Associates.

Authors: Sally Ward, Katharine Hall and Alastair Clacherty

Price: US\$ 15 (via surface mail)

Soul City is a multi-media health education and entertainment strategy, which uses the mass media as a vehicle to communicate health and development messages to South African audiences. In 1997 the Health Education and Awareness Task Team approached Soul City with a request to include water and sanitation messages in their television, radio and print materials.

Research is the foundation for the development of educational messages conveyed through the Soul City programmes, because it helps to ensure that materials are popular, messages are appropriate and that the audiences remain loyal. Soul City therefore commissioned research to identify key



messages and how the electronic media could best be applied to education around water and sanitation issues. The research, funded by the Water Research Commission, comprised primary research conducted through social surveys and a literature review.

This report provides a synthesis of the major findings from the investigation and discusses the application of the results to the Soul City vehicle.

The key outcome of the research was the decision not to use the electronic media to carry national water and sanitation messages. This decision was

taken in the light of the finding that information needs are dependent on a number of factors and differ from area to area. Needs cannot be generalised, but are linked to contextual factors such as infrastructure, cultural beliefs and practices as well as human and other resources.

The report states that it is important to distinguish between universal messages which are applicable to a wide target audience, from those which are specific to people living under similar conditions engaging in similar health practices. Whereas the latter are most effectively conveyed through localised health promotion initiatives, the former may also be popularised as educational messages via the mass media.

Both the specificity (as opposed to universality) of many water and sanitation issues, and the fact that people's health and hygiene behaviour depends on water and sanitation infrastructure, imply a supportive, rather than leading role for the mass media in terms of health promotion.

The role of the mass media at a national level needs to be conceptualised as an auxiliary strategy to "back up" local level initiatives which are better geared to address health and hygiene issues in the local context. The mass media's contribution should therefore be to raise awareness about those water and sanitation issues which have wide relevance. 

Report - TT 136/00 - Hydrogeology of groundwater: Region 3 - Limpopo Granulite- Gneiss Belt

Report to the Water Research Commission by JR Vegter Hydrological Consultants.

Author: JR Vegter

Overseas price: US\$ 20 (via surface mail)

The third region to be described in the

Monograph on South Africa's Groundwater Resources, compiled for the Water Research Commission by JR Vegter, a hydrogeological consultant, is the Limpopo granulite-gneiss belt.

The region is situated in the Northern Province. The belt is lenticular in shape and adjoins the Limpopo River for most of the way between longitudes 27 and 31. The region is about 375 km long and measures 60 km at its widest.

There are, apart from Messina, an appreciable number of villages, small communities and informal rural settlements in the region. Economic activi-

ties consist of cattle and game ranching, irrigation along the major rivers, copper and diamond mining.

West of Messina Region 3 is a monotonous flat to gentle undulating bush-clad expanse, occasionally broken by hills consisting of metaquartzite and magnetite quartzite. The topography is more varied east of Messina where the country is characterised by rolling hills and ridges. The vegetation comprises several types of Bushveld. The climate is semi-arid subtropical. Rain, which falls during summer, tends to be erratic, varying from a mean of 425 mm in the west to about 300 mm in the

extreme east. Except for the larger rivers, which do not necessarily have year-round flows, water for house-hold use, cattle and game ranching has to be tapped by means of boreholes. In places along the Mokolo, Lephala and Limpopo River groundwater is withdrawn for irrigation by means of wellpoints.

Polymetamorphosed and highly deformed supracrustal and intrusive rocks of Swazian age and belonging to the Central Zone of the Limpopo Mobile Belt occupy most of Region 3. The supracrustal rocks consist of meta-quartzite, magnetite quartzite, metapelite, granulite, leucogneiss, calc-silicate rock and marble. Intrusive rocks comprise biotite gneiss, meta-anorthosite, metagabbro, serpentinite, metapyroxenite and hornblendite.

Included in Region 3 are quartzites and conglomerates of the Koedoesrand Formation, granite, mylonite, ultramylonite and mylonitized gneisses of the Palala Shear Zone, Bushveld gabbro and granite and some outliers of Soutpansberg quartzitic sandstone and Karoo strata. With the exception of alluvium along the major rivers, other widespread surficial Tertiary and Quaternary deposits in the form of river terrace gravels, sand, calcrete and ferricrete, do not feature as water-bearing formations.

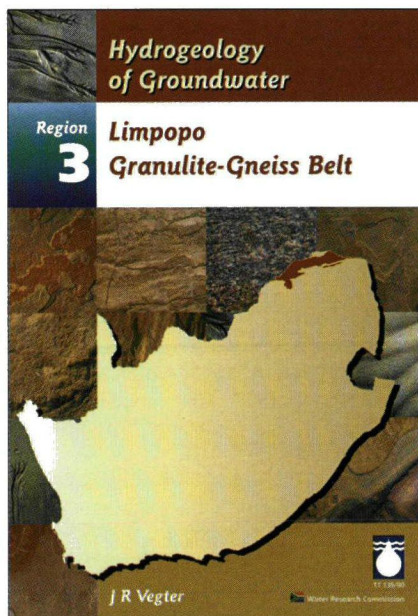
The Limpopo Mobile Belt has been intruded by east-west striking granite dykes, pegmatites and diabase and dolerite dykes, generally striking east-northwards and west-northwards. Major east-northeasterly trending zones of shearing, faulting and brecciation are present in the Limpopo Mobile Belt. Of them the Palala Shear Zone is the most notable. Horst and Graben structures are present north of the Soutpansberg. Analysis of satellite imagery aeromagnetic trends has led to the identification in the Swartwater area of a direction of normal faulting striking 10 east of north and of shear- ing 15 west of north.

DRILLING RESULTS

Beyond determining the extent of irrigation with groundwater along the main rivers, no hydrogeological investigation of the alluvial deposits has been under-

taken. Past hydrogeological work has been restricted to the hard-rock formations. Drilling results in hard-rock formations are poor for most of Region 3. About 40 per cent of the boreholes that have been drilled by government machines yield more than 0.1 litre per second. The great majority of these holes were not sited by (hydro-) geologists or geophysicists.

Depending on the location, the maximum optimal strike depth ranges between 50 and 85 m below the surface and between 15 and 25 m below the water level.



Data of boreholes drilled into rocks of the Limpopo Mobile Belt have been analysed statistically in terms of water level frequency, water strike frequency below surface and below water level, cumulative borehole depths, water level and water strike frequencies and yield - strike depth relationship. For this purpose, the region was divided into five subregions. Depending on the location, the maximum optimal strike depth ranges between 50 and 85 m below the surface and between 15 and

25 m below the water level. Higher yields normally do not go hand-in-hand with greater strike depth below water level. The deeper piezometric level of the Beauty area not only results from the greater depth and larger storage coefficient of weathered rock but also reflects the dynamic balance between groundwater recharge and loss. Loss is presumably almost totally through groundwater outflow to a low-lying area that is situated a considerable distance beyond the confines of the Beauty area. Here conceivably dispersed discharge through evapotranspiration would escape notice. The occurrence of thermal water at various places in the region lends support to the idea of deeper and longer groundwater flow paths.

The limited volume of groundwater in storage that can be drawn on by a borehole and the irregularity of recharge recurring are evident from the weakening and drying-up of boreholes during droughts as well as rest level drops of up to 20 m and more that have been recorded in the vicinity of pumped holes.

Declining borehole yields and water levels do not necessarily indicate permanent and regional lowering of the water level. In the area west of the Lephala River some water levels were several metres higher and others several metres lower in 1987/88 than during the early fifties. In two areas cleared of bush during the fifties, water levels were 5.6 to 17 m higher. On the other hand, the known cessation of spring flow on several farms, the non-existence of springs coupled with currently deep water levels on farms bearing names ending with the suffix "fontein" may be cited as evidence of gradual imperceptible environmental changes, perhaps through bush encroachment. Water levels rise significantly only during periods of high rainfall. Brief recharge periods are followed by lengthy periods of water level decline.

The total dissolved solids content of groundwater in the region ranges between 500 and 2 000 mg per litre. More than 50 per cent of groundwater samples analysed were found to be unsuitable for human consumption mainly as a result of high nitrate and fluoride concentrations. 

SOUTHERN
AFRICA

2002

DESERTIFICATION

APRIL 8 - 10

An international symposium on alternative ways to combat desertification - Connecting community action with science and common sense - will be held in Cape Town.

Enquiries: Mary Seely, Desert Research Foundation of Namibia, PO Box 20232, Windhoek, Namibia. Tel: +264 61 229855. Fax: +264 61 230172. E-mail: mseely@drfn.org.na

ENVIRONMENT

APRIL 8 - 10

A new training course on environmental compliance, sustainable development and business opportunities will be held by WSP Walmsley in Johannesburg.

Enquiries: Sharali Barnard - Tel: 011- 233 7886/7. E-mail address: training@wspgroup.co.za

ENVIRONMENTAL
MANAGEMENT

APRIL 16 - 18

A short course on environmental management will be presented by the Environmental Engineering Group at the University of Pretoria.

Enquiries: Ms Tanya de Bruin. Tel: (012) 420 5015. Fax: (012) 362 52 85. E-mail address: tanya.ce@up.ac.za

EMS (ISO14001)

MAY 6 - 10

An IEMA accredited training course on EMS (ISO14001) implementation and internal audit will be held by WSP Walmsley in Cape Town.

Enquiries: Sharali Barnard - Tel: 011- 233 7886/7. E-mail address: training@wspgroup.co.za

ENVIRONMENTAL LAW

MAY 6 - 10

A course on environmental law will be held at the Centre for Environmental Management at the University of Potchefstroom.

Enquiries: Mrs Dydré Greeff, Section for Training Co-ordination, PU for CHE. Tel: (018) 299-2714 or 299-2725. Fax: (018) 299-2726. E-mail: aokdg@puknet.puk.ac.za Web: www.puk.ac.za/bbdwww/aok/index.htm

AIR QUALITY MANAGEMENT

MAY 7 - 8

A short course on air quality management will be presented by the Environmental Engineering Group at the University of Pretoria.

Enquiries: Ms Tanya de Bruin. Tel: (012) 420 5015. Fax: (012) 362 52 85. E-mail address: tanya.ce@up.ac.za

NOSHCON 2002

MAY 7 - 10

NOSA will be hosting the 41st international Occupational Safety, Health and Environmental Risk management conference and exhibition - NOSHCON - at Sun City.

Enquiries: NOSA, PO Box 26434, Arcadia 0007. Tel: (012) 303 9700. Fax: (012) 303 9856. E-mail: noshcon@nosa.co.za

WATER QUALITY

MAY 13 - 17

A short course on water quality management will be held at the Centre for Environmental Management, University of Potchefstroom.

Enquiries: Mrs Dydré Greeff, Section for Training Co-ordination, PU for CHE. Tel: (018) 299-2714 or 299-2725. Fax: (018) 299-2726. E-mail address: aokdg@puknet.puk.ac.za Web: www.puk.ac.za/bbdwww/aok/index.htm

WISA

MAY 19 - 23

The Water Institute of Southern Africa (WISA) will hold its next biennial meeting at the ICC conference centre in Durban.

Enquiries: Cilla Taylor, Conference Planners. Tel: (012) 667-3681. Fax: (012) 667-3680. E-mail: confplan@iafrica.com

ENVIRONMENTAL
MANAGEMENT

MAY 20 - 23

A course on Environmental management systems (SABS/ISO 14001) will be held at the Centre for Environmental Management, University of Potchefstroom.

Enquiries: Mrs Dydré Greeff, Section for Training Co-ordination, PU for CHE. Tel: (018) 299-2714 or 299-2725. Fax: (018) 299-2726. E-mail address: aokdg@puknet.puk.ac.za Web: www.puk.ac.za/bbdwww/aok/index.htm

WATER LAW

JUNE 24 - 28

A course on the new water law will be held at the Centre for

Environmental Management, Potchefstroom University.

Enquiries: Mrs Dydré Greeff, Section for Training Co-ordination, PU for CHE. Tel: (018) 299-2714 or 299-2725. Fax: (018) 299-2726. E-mail: aokdg@puknet.puk.ac.za Web: www.puk.ac.za/bbdwww/aok/index.htm

AQUATIC SCIENCE

JUNE 30 - JULY 5

A joint congress of the Southern African Society of Aquatic Scientists (SASAqS) and the Southern African Institute of Ecologists and Environmental Scientists (SAIE & ES) will be held at the University of the Free State in Bloemfontein. The theme will be "Research, conservation and management of ecosystems in Southern Africa".

Enquiries: Dr JC Roos, Centre for Environmental Management, UFS, PO Box 339, Bloemfontein 9300. Tel: (051) 401 2265. Fax: (051) 401 2629. E-mail address: roosjc@sci.uovs.ac.za

SACI2002

JULY 1 - 5

The 36th convention of the South African Chemical Institute will be held in Port Elizabeth.

Enquiries: Dr CD Woolard, Department of Chemistry, University of Port Elizabeth, PO Box 1600, Port Elizabeth 6000. E-mail: SACI2002@UPE.AC.ZA

EMS (ISO14001)

JULY 1 - 5

An IEMA accredited training course on EMS (ISO14001) implementation and internal audit will be held by WSP Walmsley in Durban.

Enquiries: Sharali Barnard - Tel: 011- 233 7886/7. E-mail address: training@wspgroup.co.za

ENVIRONMENTAL AUDITING

JULY 1 - 5

A short course on Environmental Auditing will be held at the Centre for Environmental Management, University of Potchefstroom.

Enquiries: Mrs Dydré Greeff, Section for Training Co-ordination, PU for CHE. Tel: (018) 299-2714 or 299-2725. Fax: (018) 299-2726. E-mail address: aokdg@puknet.puk.ac.za Web: www.puk.ac.za/bbdwww/aok/index.htm

ECOLOGICAL
REHABILITATION

JULY 29 - AUGUST 1

A short course on the basic prin-

ciples of ecological rehabilitation and mine closure will be held at the Centre for Environmental Management, Potchefstroom University.

Enquiries: Mrs Dydré Greeff, Section for Training Co-ordination, PU for CHE. Tel: (018) 299-2714 or 299-2725. Fax: (018) 299-2726. E-mail address: aokdg@puknet.puk.ac.za Web: www.puk.ac.za/bbdwww/aok/index.htm

ENVIRONMENT

SEPTEMBER 4 - 6

A new training course on environmental compliance, sustainable development and business opportunities will be held by WSP Walmsley in Johannesburg.

Enquiries: Sharali Barnard - Tel: 011- 233 7886/7. E-mail address: training@wspgroup.co.za

ENVIRONMENTAL
MANAGEMENT

SEPTEMBER 17 - 19

A short course on environmental management will be presented by the Environmental Engineering Group at the University of Pretoria.

Enquiries: Ms Tanya de Bruin. Tel: (012) 420 5015. Fax: (012) 362 52 85. E-mail address: tanya.ce@up.ac.za

HYDRAULIC ENGINEERING

DECEMBER 4 - 6

The International Association for Hydraulic Research (IAHR) African Division's biennial congress with the theme "Water - the lifeblood of mankind" will be held in Arusha, Tanzania.

Enquiries: The Institution of Engineers, PO Box 2938, Dar-es-Salaam, Tanzania. E-mail: iet@iet.co.tz Tel: +255 22 212 4265. Fax: 212 2836. Web: http://www.iet.co.tz

OVERSEAS

2002

WATER RESOURCES

APRIL 8 - 12

An international workshop on integrated water resource management will be presented by the United States Department of the Interior's Bureau of Reclamation in Denver, Colorado, USA.

Enquiries: International Affairs Team, D-1520, US Bureau of

Reclamation, PO Box 25007, Denver, Colorado 80225. Tel: 303-445-2127. Fax: 303-445-6322. E-mail address: Lprincipe@do.usbr.gov Web address: <http://www.usbr.gov>

SEWER PROCESSES

APRIL 15 - 17

The 3rd international conference on sewer processes and networks will be held in Paris, France.

Enquiries: GRAIE - 3rd SPN Conference, Secretariat, BP 2132, 69603 Villeurbanne cedex - France. Tel: +33 4 72438368. Fax: +33 4 7239277. E-mail: graie@urgc-hu.insa-lyon.fr

BIOTECHNOLOGY

APRIL 15 - 17

The 2nd environmental biotechnology conference focusing on applications of biotechnology for treatment and utilisation of industrial wastes and by-products will be held in Palmerston, New Zealand.

Enquiries: Conference Secretary, Office of the Principal, Massey University, Private Bag 11-222, Palmerston North, New Zealand. Tel: +64 63505243. Fax: +64 63505862. E-mail: M.K.Edwards@massey.ac.nz

DESALINATION

MAY 4 - 7

A conference on the desalination strategies in southern Mediterranean countries will be held in Sharm El Sheikh, Sinai, Egypt. Enquiries: The European Desalination Society, Att: Miriam Balaban, Science and Technology Park of Abruzzo, Via Antica Arischia 1, 67100 L'Aquila, Italy. Tel: +39 0862 3475 308. Fax: +39 0862 3475 213. E-mail: miriam.balaban@aquila.infn.it

GROUNDWATER

MAY 12 - 17

An international groundwater conference with the theme - Balancing the groundwater budget - will be held by the International Association of Hydrogeologists (Australian Chapter) in Darwin, Australia.

Enquiries: Des Yin Foo IAH (NT), PO Box 95, Palmerston, NT 0831, Australia. Fax: (61) 8 8999 3666. E-mail address: des.yinfoo@nt.gov.au

WATER QUALITY

MAY 21 - 22

A conference on automation in water quality monitoring will be held in Vienna, Austria.

Enquiries: E-mail address: Mail@iwga-sig.boku.ac.at Web: www.iwga-sig.monet.boku.ac.at Tel: +43 (0) 1 36006 5800. Fax: +43 (0) 1 3689949.

ECWATECH-2002

JUNE 4 - 7

The 5th international congress and trade fair - Water, Ecology and Technology will be held in Moscow, Russia.

Enquiries: Sergey Malygin, SIBICO International Ltd, PO Box 173, Moscow, 107078 Russia. Tel/Fax: +7 (095) 975 1354, 975 5104. E-mail address: ecwatech@sibico.com Web address: www.sibico.com/ecwatech/index.htm

WATER UTILITIES

JUNE 12 - 14

A conference on the management of productivity at water utilities will be held at Praha in the Czech Republic.

Enquiries: Katerina Slaviakova, Aquion s.r.o., Delnika 38, CZ-170 00 Praha 7, Czech Republic. Tel: +420 283872265. Fax: +420 283872266. E-mail address: ManProWU@aquion.cz

AWWA

JUNE 16 - 20

The American Waterworks Association's annual conference and exhibition will be held in New Orleans, USA.

Enquiries: David Rossiter, AWWA, USA. E-mail address: rossiter@awwa.org Tel: +303 347 6209. Web address: <http://www.awwa.org/tande/awwacconf.htm>

GROUNDWATER

JUNE 17 - 19

A conference on soil and groundwater pollution induced by the transport industry will be held in Oslo, Norway.

Enquiries: Transport and Pollution, Department of Geology, PO Box 1047, Blindern 0316 Oslo, Norway. Fax: +47 22 85 42 15. E-mail address: transp-pollution@geologi.uio.no

GROUNDWATER

JUNE 17 - 20

ModelCARE 2002 - the 4th international conference on calibration and reliability in groundwater modelling (a few steps closer to reality) will be held in Prague, Czech Republic.

Enquiries: Conference Secretariat, ModelCARE 2002 Guarant Ltd, Opletalova 22, 110 00 Prague 1, Czech Republic. Tel:

+420 2 8400 1444. Fax: +420 2 8400 1448. E-mail address: modelcare2002@guarant.cz Website: <http://www.guarant.cz/ModelCARE2002>

HYDROINFORMATICS

JULY 1 - 5

The 5th international conference on hydroinformatics - Hydroinformatics 2002 - will be held in Cardiff, UK. Hydroinformatics is concerned with the application of computer and networking technology for the planning, management and protection of the water environment.

Enquiries: Cherrie Summers, Hydroinformatics 2002, Conference Secretariat, Cardiff University, Cardiff School of Engineering, PO Box 925, Newport Road, Cardiff CF24 0YF, UK. Tel/fax: +44 29 20874421. E-mail: summersc@cardiff.ac.uk Web address: <http://www.cf.ac.uk/engin/news/confs/hydro>

ISWA 2002

JULY 8 - 12

The International Solid Waste Association (ISWA) world environment congress and exhibition will be held in Istanbul, Turkey. Theme: Appropriate environmental and solid waste management and technologies for developing countries.

Enquiries: MICWORLD, Bagdat Cad. No: 254/2-8 81060 Gütepe, Istanbul, Turkey. Tel: +90 216 467 5398. Fax: +90 216 302 5216. E-mail: iswa2002@iswa2002.org Web: <http://www.iswa2002.org>

IRRIGATION

JULY 21 - 28

The 53rd IEC meeting and 18th international congress on irrigation and drainage will be held in Montreal, Canada.

Enquiries: Jean-Marcel Laferriere, Chairperson of the Organising Committee, CIDA, 200 Promenade du Portage, Hull, QC K1A 0G4 Canada. Tel: +1 819953 4327. Fax: +1 819 994 0251. E-mail address: jeanmarc-laferriere@ACDI-CIDA.GC.CA CSCE/ASCE

JULY 21 - 24

The 2002 joint CSCE/ASCE international conference with the theme - An international perspective on environmental engineering will be held at Niagara Falls in Canada.

Enquiries: Professor Richard G Zytner. E-mail: CSCEASCE_2002@yahoo.ca Web: www.eos

uoguelph.ca/webfiles/CSCE_ASCE_2002

WATER RESOURCES

JULY 22 - 26

The 3rd international conference on water resources and environmental research (ICWRER) with the theme "Water quantity and quality aspects in modelling and management of ecosystems will be held in Dresden, Germany.

Enquiries: Conference Secretariat ICWRER 2002, Institute of Hydrology and Meteorology, Dresden University of Technology, Wuerzburger Str 46, 01187 Dresden, Germany. Tel: +49 351 463 3931. Fax: +49 351 463 7162. E-mail: icwrrer2002@mailbox.tu-dresden.de Web address: www.tu-dresden.de/fghhi/hm/hydrologie.html

DAM SAFETY

AUGUST 12 - 23

An international technical seminar and study tour on dam safety, operation and maintenance will be presented by the US Department of the Interior's Bureau of Reclamation in Denver, Colorado, USA.

Enquiries: International Affairs Team, D-1520, US Bureau of Reclamation, PO Box 25007, Denver, Colorado 80225. Tel: 303-445-2127. Fax: 303-445-6322. E-mail address: Lprincipe@do.usbr.gov Web: <http://www.usbr.gov>

SOIL SCIENCE

AUGUST 14 - 21

The 17th world congress on soil science - confronting new realities - will be held in Bangkok, Thailand.

Enquiries: Mrs Catherine Vachon. Tel: 1 403 317 2257. Fax: 1 403 382 3156. E-mail: vachonc@em.agr.ca Web: www.res2.agr.ca/lethbridge/hebel/confindex.htm

ACID SOILS

AUGUST 25 - 30

The 5th world acid sulphate soils conference will be held at the Quality Resort Twin Towns, Tweed Heads, NSW Australia.

Enquiries: Jacki Rose. Tel: 0011 61 75536 4000. Fax: 0011 61 7 5599 5167. E-mail address: hwtweedm@onthenet.com.au Web: www.acrosc69.webcentral.com.au/aciddates.html

HYDROGEOLOGICAL MAP SERIES OF THE REPUBLIC OF SOUTH AFRICA

1: 500 000



Prepared by the Department : Water Affairs and Forestry



The following South African 1 : 500 000 General Hydrogeological maps and brochures are available as from April 1999

The General Hydrogeological maps provide a synoptic overview of the hydrogeological character of the area by processing groundwater-related data according to a standard legend.

EACH SINGLE A0 MAP SHEET COMPRISES :

MAIN MAP :

Groundwater occurrence (borehole yields and aquifer type) superimposed on lithological background
(Scale 1 : 500 000)

INSET MAPS :

- Distribution of borehole data (Scale 1 : 2 000 000)
- Elevation above sea level (Scale 1 : 2 000 000)
- Mean annual precipitation (Scale 1 : 2 000 000)
- Groundwater quality (Scale 1 : 1 500 000)

MAPS :

- | | | |
|-----------------------|---------------------|----------------------|
| • 2330 Phalaborwa | • 2526 Johannesburg | • 2726 Kroonstad |
| • 2730 Vryheid | • 3321 Oudtshoorn | • 2714 Alexander Bay |
| • 2928 Durban | • 3317 Cape Town | • 2718 Upington |
| • 3126 Queenstown | • 2530 Nelspruit | • 2916 Springbok |
| • 3324 Port Elizabeth | • 2522 Vryburg | • 2920 Prieska |

BROCHURES :

- 3126 Queenstown
- 3324 Port Elizabeth
- 3321 Oudtshoorn
- 2526 Johannesburg
- 3317 Cape Town

SCHEMATIC CROSS-SECTION:

A schematic illustration of typical modes of groundwater occurrence
(Not to scale)

ACCOMPANYING BROCHURE:

Provides additional information concerning groundwater occurrence and related matters

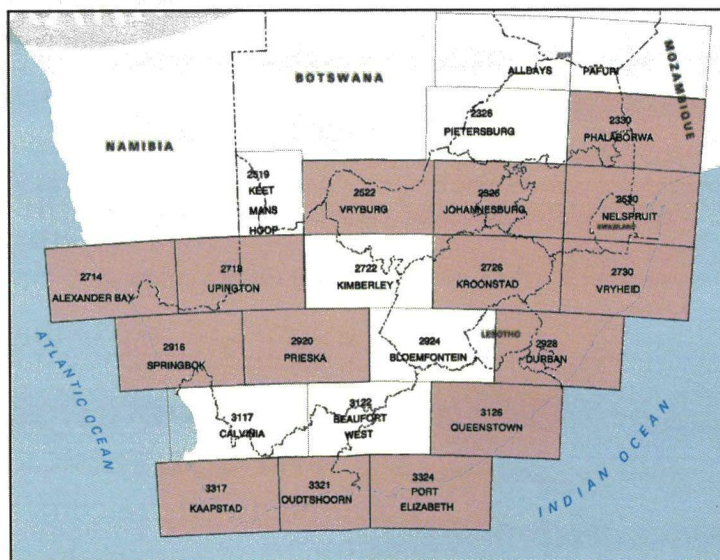
PRICE :

R50.00 per map
R50.00 per brochure } (VAT, postage and packing included)

Copies of the maps and brochures are obtainable from:

Ms. M. van Wyk
Department : Water Affairs and Forestry
Directorate : Geohydrology
Emanzini Building R310
173 Schoeman Street
Pretoria
0001

Tel: (012) 336 7849
Fax: (012) 328 6397
E-mail: WB3@dwaf.pwv.gov.za



Website: <http://www-dwaf.pwv.gov.za>

WISA 2002

THE BIENNIAL CONFERENCE AND EXHIBITION of the WATER INSTITUTE OF SA

will be held at the ICC, Durban
from 19th to 23rd May 2002
(technical tours on Thursday, 23rd May)

Workshops and seminars include ...

- Workshop on algal research for water utilization
- Workshop on tools for cleaner production
- Workshop on the World Summit on Sustainable Development
- Workshop on membrane technology: separating the past and the present
- Workshop on water conservation
- Seminar on leakage management
- Workshop – Update on sustainable implementation of legislation
- Workshop on passive water treatment systems for mine water
- Technical discussion on training needs for the production of drinking water

130 oral papers – 150 posters

Technical tours

Companions' programme

*A Cocktail Meet-and-Greet (Zetachem), an all-singing-all-dancing
Conference Dinner (Umgeni Water) and a Closing Party (Sud Chemie)
to send you home happy*

*not forgetting the
Golf Day – 19th May
and, of course the exhibition*

**LET DURBAN SHOW YOU WHAT IT HAS TO OFFER – AND LET WISA
WOW YOU WITH ANOTHER PREMIER CONFERENCE**

**confplan@iafrica.com, tel: 011/667-3681
for a final announcement and enrolment forms**