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WATER QUALITY MANAGEMENT POLICIES AND STRATEGIES IN THE RSA

Department of Water Affairs and Forestry

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WATER QUALITY MANAGEMENT POLICIES AND STRATEGIES IN THE REPUBLIC OF SOUTH AFRICA

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PREFACE

The necessary powers to exercise control over the management of South Africa's water resources are vested in the Minister of Water Affairs and Forestry by the Water Act of 1956. The Department's approach to the effective management of water resources was described in 1986 in the publication "Management of the Water Resources of the Republic of South Africa".

Since then the Department has been reviewing its water quality management policy and strategies and has implemented a new approach to water pollution control which forms an integral and major part of water quality management. In implementing this approach the Department appreciates that far-reaching policy and strategy changes will be required and plans to embark on a number of investigations.

This document spells out the status quo of the Department's water quality management policies, possible future trends and areas where policies and strategies may have to be adopted after proper evaluation. It is therefore directed at those interested in the environment in general and water quality management in particular for comment and evaluation. It confirms the Department's belief that those affected by the Department's policies and the execution thereof, should participate in decision-making.

In view of the President's Council's current investigation into management of the environment, the various departments and authorities involved in water quality management, the various acts impacting on the water environment and the associated overlapping of activities calling for coordination, have not been addressed.

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WATER QUALITY MANAGEMENT POLICIES AND STRATEGIES IN THE REPUBLIC OF SOUTH AFRICA

Far reaching economic, political, social and demographic changes throughout the Republic of South Africa have had major impacts on water quality. There has been a steady decline in water quality countrywide. As a result, the Water Affairs branch of the Department of Water Affairs and Forestry (referred to as Water Affairs) has embarked upon a programme to re-evaluate and develop its water quality management policies.

The purpose of this document is to -

- provide a perspective on water quality problems in South Africa;
- review current Water Affairs water quality management policies and strategies;
- review the development of appropriate policies to deal with deteriorating water quality in the light of economic and socio-political trends.

South Africa's surface and groundwater resources show pronounced regional differences and changes in water quality. The changes in those areas where water quality has deteriorated significantly are mostly due to man's activities. Exceptions are the ambient salinity levels of certain rivers of the eastern and western Cape where natural salination is of geological origin.

Salination of surface water resources and eutrophication present the most serious current water quality problems. Some of the groundwater resources of the country have already been contaminated. Micropollutants, microbiological quality and sedimentation also warrant urgent attention.

Water Affairs is the custodian of a limited national resource which has to be judiciously managed to ensure continued adequate water supplies of acceptable quality for all recognised uses. From the quality point of view, recognised uses as defined in the Water Act, 1956 (Act 54 of 1956) are: domestic, industrial, agricultural, environmental and recreational. Custodianship applies not only to inland ground and surface water resources but also to South Africa's coastal-marine environment.

Maintenance of the fitness for use of South Africa's water resources on a sustained basis is thus Water Affairs' major overall water quality management goal. The fitness for use concept implies the evaluation of water quality in terms of the requirements of a particular user or categories of users. It is usually measured against water quality criteria or norms that have been established as representing the ideal water quality for a particular use.

Until recently Water Affairs applied the Uniform Effluent Standards approach to water pollution control by enforcing compliance with the General and Special effluent standards. To counter continuing deterioration of water quality and to meet the challenges of the future, Water Affairs changed to the Receiving Water Quality Objectives approach for non-hazardous substances and to the Pollution Prevention approach for hazardous substances. The Receiving Water Quality Objectives approach focuses on the fundamental water quality management goal, namely maintaining fitness for use.

Generally, this approach has been favourably received both by industry and local authorities that have to comply with the effluent standards and those who are concerned with protection of the environment. Both groups perceive it as a rational process for reaching decisions regarding pollution control.

However, applied without the necessary precaution, the Receiving Water Quality Objectives approach, as defined, will inevitably lead to the deterioration of water resources to the point where they will be marginally fit for the recognised uses.

To counter the limitations of this approach and consistent with environmental policy development worldwide, Water Affairs has decided to embody in its water quality management policy aspects of the anticipatory or precautionary principle to environmental protection. This principle encompasses all types of action to avert danger and minimise risk to the environment.

The consistent execution of this policy will require a hierarchy of water quality management goals. The hierarchy contains elements of Water Affairs' present policy but embodies the precautionary principle in the form of both source reduction and the application of minimum effluent standards. Until the policy is fully operational the current General and Special Effluent Standards can provisionally serve as minimum effluent standards. The hierarchy of water quality management goals is as listed here:

- Source reduction, recycling, detoxifying, and neutralisation of wastes will be encouraged. As mandatory standards for waste reduction or minimisation are not currently feasible, Water Affairs will promote voluntary action.

- If there is no alternative to the discharge of an effluent, the effluent must meet minimum standards, which may be either uniform or industry-related. The current General and Special Effluent Standards can probably be adapted to serve as minimum standards.

- If the application of minimum effluent standards is not sufficient to maintain the fitness for use of the receiving water body, then standards stricter than the minimum standards will be enforced. Such stricter standards will be site-specific and will be based on the results of a waste load allocation investigation, in accordance with the Receiving Water Quality Objectives approach.

- Exemptions from compliance with the minimum effluent standards will be considered only as a last resort and only if the receiving water quality body has enough assimilative capacity (ie. capability to absorb the waste without affecting its fitness for use). Relaxations would have to be justified on the basis of technological, physical, economical and socio-political considerations.

To ensure consistency in the application of this hierarchy to individual cases, decision-making guidelines have to be developed. These guidelines must be accessible to the general public and have to be clear and easily understood.

The water quality management policies and strategies addressed in this document are mainly applicable to surface water resources and to the coastal marine environment. The need for policies and strategies to deal with ground water pollution is clearly identified. It is proposed that ground water protection policies should range from maintaining groundwater quality in a pristine condition to setting water quality objectives in accordance with the requirements of recognised uses, the specific aquifer or a specific groundwater region.

Cognisance must be taken of the following factors that fundamentally affect the development of water quality management strategies and policies:

- Because South Africa is a water scarce region, reuse of effluent is a vitally important supplement to freshwater resources. Effluent, with the accompanying pollutants, must therefore be returned to the natural water bodies for reuse. It is important to note that the Water Act, in common with water pollution control legislation in most developed countries of the world, does not require the water authority to ensure that the quality of marine and fresh water resources should remain in a pristine state unless this can be justified for the purpose of meeting the requirements of one of the recognised water uses.

- It is accepted that the water environment normally has a capacity, usually quantifiable, to assimilate non-hazardous pollutants without detriment to predetermined quality objectives. This assimilative capacity is part of the water resource and must be judiciously managed and equitably shared by all water users.

- For those pollutants that are hazardous and a threat to the environment by virtue of their toxicity, persistence and extent of bio-accumulation, a precautionary approach should be adopted, aimed at minimising or preventing their entry into the water environment.

- Water quality is highly variable. Many factors, some unknown and many random, affect water quality. The resulting uncertainties introduce risks in decision-making and therefore necessitates the interpretation of water quality in probabilistic terms.

- Increasing environmental awareness and consequent public involvement with issues concerning protection of the ecology demands that, whatever water quality management policy is adopted, it must be easy to understand, simple to operate and accessible so as to maintain public confidence in the system.

The following conclusions can be drawn:

- Water quality and water supply management are integral parts of overall water resource management and should therefore remain the responsibility of a single authority.

- Water quality management must also be integrated with national environmental management policies, and the selection of the best practical environmental options rather than merely the best practical water quality options must be investigated.

- Representatives of water users should be intimately involved in decision-making concerning the determination of the desired quality of the resource of which they are the recognised users.

- In a choice between different effluent disposal options, Water Affairs will in principle support the best option from an economical, technological, social, political and environmental point of view.

- The polluter pays principle requires dischargers of effluent to meet the cost of treating their effluents and of repairing the consequences to the environment of their discharges.

- Water Affairs is investigating incentive-based pollution control strategies to supplement the command-and-control and polluter pays principles.

- A co-operative rather than an adverserial approach will be sought to solve pollution problems. Charges should be laid only as a last resort where the offender is wilfully and/or negligently violating the requirements of the Water Act and is clearly unwilling to take the necessary steps to comply.

- Historically emphasis was placed on the protection of the quality of South Africa's surface and marine water resources. Policies and strategies to deal with groundwater pollution require urgent attention. Establishment of a differentiated protection policy is favoured.

- Pollution control efforts so far have been directed mainly to point source pollution. Studies have been initiated to address control of non-point pollution sources, such as contaminated stormwater runoff from mining, urban and informal settlements.

Future policy development and implementation will be prioritized. Adaptation of the General and Special Effluent Standards to comply with the proposed minimum or industry related standards is urgently needed. Decision-making criteria and guidelines for the consistent execution of various water quality management policies will have to be addressed. This is especially urgent for the rational application of the hierarchy of water quality management goals.

The challenge to maintain the fitness for use of the country's water resources, will depend on the implementation of effective and dynamic water quality management policies and strategies, flexible enough to meet the demands of an increasingly complex and rapidly changing South Africa.

The successful implementation of these technologically more demanding new policies and strategies will require additional and more experienced manpower resources.

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1. INTRODUCTION

Far-reaching economic, political, social and demographic changes throughout the Republic of South Africa have had major impacts on water quality. There has been a steady decline in water quality countrywide. As a result, the Water Affairs branch of the Department of Water Affairs and Forestry (referred to as Water Affairs) has embarked upon aprogramme to re-evaluate and develop its water quality management policies.

The purpose of this document is to -

- provide a perspective on water quality problems in South Africa;
- review current Water Affairs' water quality management policies and strategies;
- review the development of appropriate policies to deal with deteriorating water quality in the light of economic and socio-political trends.

2. BACKGROUND TO WATER QUALITY MANAGEMENT IN SOUTH AFRICA

2.1 Mission with respect to water quality management

Unfavourable climatic conditions, uneven geographic distribution of water resources and upward spiralling demands, in step with rapidly multiplying population mean that water is becoming scarce in many parts of the country. Moreover the limited water resources have to be shared not only among competing users in South Africa but also with neighbouring states.

As its mission, Water Affairs accepts responsibility as custodian of a limited national resource which has to be judiciously managed to ensure continued adequate supplies of water of acceptable quality for recognised uses. In terms of water quality, the uses defined by the Water Act are: domestic, industrial, agricultural, recreational and environmental uses. Custodianship applies not only to inland ground and surface water resources but also to South Africa's coastal marine environment. In striving to achieve its goal of maintaining fitness for use of water resources, Water Affairs accords precedence to the protection of human health.

2.2 History of water quality management in South Africa

South Africa started experiencing environmental pollution problems during the first half of the century, with the development of towns and industries and the associated accumulation of wastes in built-up areas. Initially, control of water pollution in South Africa focused on the development of acceptable sewage disposal methods. Water quality management, however, dates from the promulgation of the Public Health Act of the Union of South Africa, 1919 (Act 36 of 1919). This Act gave the Chief Health Officer of the Public Health Department the responsibility of controlling pollution by ensuring that 'the best known or the only or the most practical methods' for sewage disposal were being used. This allowed the Chief Health Officer to prevent effluent from sewage treatment works from being discharged into water courses. It was a requirement that sewage or sewage effluent had to be disposed of on land.

In moving from the pre-1950 to the post-1950 era, South Africa underwent a change from an agriculturally based economy to one in which industry and mining played the major role. These changes coincided with the evolution from its early beginnings as the Department of Irrigation to the present-day Department of Water Affairs and Forestry. The next major milestone was the promulgation of the Water Act in 1956. The Water Act aimed at the control of industrial use of water and the treatment and disposal of effluent. By 1956 it was becoming apparent that reconciling water supply with water demand would be increasingly difficult and that re-use of effluent would have to play a major role in the management of the country's scarce water resources. After 1956 the earlier requirement of the health authorities that prohibited the disposal of effluents to natural water courses, had to fall away. The Water Act in fact required that all effluent be returned to the water body from which the water was originally abstracted.

Later amendments, notably the Water Amendment Act, 1984 (Act 96 of 1984), broadened water quality management. Industrial effluent, and sources other than effluent, e.g. water which arises as a by-product from industrial and mining activities and seepage or stormwater runoff from a site, were made subject to pollution control regulations. The State was also given powers to counteract pollution before it takes place.

2.3 Sources of water pollution

Increasing population growth in most parts of South Africa is placing ever greater demands on the water resources available to satisfy the needs of industrialisation, urbanisation, agriculture and recreation. At the same time, all these water uses can create both point and diffuse sources of pollution of inland and coastal waters.

The principal categories of pollutants are listed below:

- Chemicals (including acids, metals, salts, inorganic compounds and organic compounds - both biodegradable and relatively non-biodegradable).

- Suspended matter (particles and colloids which are temporarily or permanently suspended in water and which can act as transport media for metals or pathogens).

- Pathogens including bacteria and viruses.

- Thermal changes including heated cooling waters or cold waters from the bottom outlets of stratified reservoirs.

- Radioactivity, if present at significant levels.

Activities that may lead to pollution of to inland waters are numerous. A few sources that cause problems worldwide and increasingly so in South Africa are listed here.

Industry

- industrial waste
- hazardous waste
- abandoned industrial sites

Urbanisation

- urban solid waste disposal (often including industrial waste)

Transport

- Spillage of hazardous substances may cause serious unforeseen point impacts.

Pollutants are introduced into aquatic ecosystems in various ways. Direct, or point source discharges, may result from accidental spills but more commonly from deliberate actions, e.g. discharges from industry, sewage treatment works or agriculture, and include both licensed and unlicensed discharges. Diffuse or non-point source inputs are less obvious and may arise from groundwater contributions to surface water systems, from aerial fallout, stormwater runoff, remobilisation of sediments, and activities in agricultural and mining areas.

The impact of a pollutant may be magnified as a result of bio-accumulation through the food chain or by chemical change.

Degradation of water resources is usually most severe in the more arid regions. There are a number of reasons, for instance: runoff and groundwater recharge are highly variable; pollutant wash-off is highly concentrated after long dry spells; pollutants are highly concentrated in the base flow of rivers; increasing re-use of water and prolonged retention in reservoirs.

2.4 Some Perspectives on the quality of South Africa's water resources.

Both the surface and the groundwater resources of South Africa are justifiably regarded as extremely valuable. Water Affairs therefore accords high priority to water quality control. The effects of polluted water on human health, on the ecology and on various sectors of the economy, including agriculture, industry and recreation can be disastrous. Moreover, deteriorating water quality leads to increased treatment costs of potable and industrial process water and decreased agricultural yields due to increased salinity of irrigation water. On the other hand, not all health, productivity and ecological problems associated with deteriorating water quality are ascribable to man's activities. Many quality-related problems are inherent in the geological characteristics of the source area.

The occurrence, transport and fate in the aquatic environment of numerous persistent and toxic metals and organic compounds (e.g. pesticides) have given cause for serious concern. Contamination of groundwater resources or of sediments deposited in riverbeds, impoundments and estuaries by these toxic and persistent compounds can cause irreversible pollution, sometimes long after the original release to the environment has ceased.

The present-day anticipatory approach to the protection of water resources and their maintenance in a state fit for use will contribute to future availability of water and to environmental conservation.

This section presents a brief overview and perspective on the quality of surface and groundwater resources in South Africa.

2.4.1 Surface water

Salination

A persistent water quality problem is salination which has two major causes: natural and anthropogenic. The origin of natural salination of river water is geological; the soil itself contains large quantities of freely mobile salts which, when leached, result in high salt concentrations in river water, e.g. in the Berg River, Western Cape, and in the Great Fish and Sundays River in the Eastern Cape.

Man-made causes are multiple. A wide variety of man's activities are associated with increased releases of salts, some in the short and others in the long term. Immediate increases in salt concentration result from point sources of pollution, such as industrial effluents, e.g. salination in the Vaal Barrage. During 1989 the median total dissolved salt concentration in the Barrage was 470 milligram/litre, rising to above 740 milligram/litre for

10 per cent of the time. Problems are generally experienced from 400 milligram/litre and above 1 500 milligram/litre the water is regarded as unsuitable for most uses.

Total dissolved salt concentrations in surface waters in South Africa range from well below the 400 milligram/litre level (good quality water, mostly in the high rainfall regions) to more than 3 000 milligram/litre (poor quality water in the dry western parts).

Of major concern in the long term is the increased salination that results from diffuse sources of pollution. There are various types associated with -

- irrigation return flows, e.g. the Harts and Riet River;
- urban runoff;
- mining activities, particularly open-cast coal mining;
- the insidious effect of fossil fuel burning that becomes apparent only after a lag-phase of several decades. Salination from this source gives cause for concern in the Vaal Dam catchment.

Over the past 40 years the total dissolved salt concentrations in the outflow from Vaal Dam have risen from less than 100 milligrams/litre during the mid-1950s to more than 150 milligrams/litre. A recent study confirmed a trend of increasing total dissolved salt concentrations in the outflow during flood conditions. This is indicative of diffuse source pollution in the catchment because the influence of point source pollution is negligible during floods.

Salination is commonly the result of a combination of point and diffuse sources of salt input. Apart from the Vaal, Olifants and Crocodile Rivers, other rivers in the Transvaal also show evidence of increased salination. The dissolved salt content of the Natal rivers, except those draining the coalfields, tends to be low because of the high rainfall. In the Eastern and Western Cape Province, natural salination of geological origin overshadows that caused by man's activities. Increasing population implies increased salination, particularly from diffuse sources.

Salinity drastically affects the suitability of water for irrigation. For instance, water high in sodium damages the clay particle structure and permeability of the soil.

Eutrophication

Another major water quality problem is eutrophication which is the enrichment of water with the plant nutrients nitrate and phosphate. These encourage the growth of microscopic green plants termed algae. As nutrients are present in sewage effluent, the problem is accentuated wherever there is a concentration of humans or animals. The algae cause problems in water purification, e.g. undesirable tastes and odours, and the possible production of trihalomethanes or other potentially carcinogenic products in water that is treated with chlorine for potable purposes.

Thirty-five dams were studied in a survey to evaluate their eutrophication status. Six per cent had a chlorophyll-a concentration in excess of 30 microgram/litre for 50 percent of the time, indicating the presence of severe eutrophication. Eleven percent had a concentration of between 10 and 30 microgram/litre, indicating incipient eutrophication problems. In a recent survey of the occurrence and concentrations of trihalomethanes in public drinking water supplies in South Africa it was found that, with few exceptions, water supplies were well within the United States Environmental Protection Agency standard of 100 micrograms/litre. Establishing a safe level for trihalomethanes in drinking water, however, is extremely complex. This is reflected in the wide variation of criteria established world-wide. For example, criteria and standards range from questionably low trihalomethane levels of 1 microgram/litre in some European countries to as high as a 350 micrograms/litre maximum acceptable concentration for Canadian public drinking water supplies.

Micropollutants

A water quality issue which is receiving increasing attention among industrialised nations is pollution by metals and by man-made organic compounds, such as pesticides. Serious incidents of health impacts to man and animals have occurred at places throughout the world through uncontrolled exposure to these micropollutants. Pollution of this type tends to be highly localized and associated with specific industries or activities where these substances are used on a large scale.

A survey of raw water intakes to various purification works in South Africa indicated that the highly toxic heavy metals, mercury, lead and cadmium, have been absent except on rare occasions and then only in low concentrations. Commonly present, however, were the metals associated with clay particles and humic acids, such as iron, aluminium and manganese.

A study of pesticide levels in the river water at Vaalharts irrigation scheme revealed that residual pesticide concentrations were well within acceptable limits.

To clarify the water quality status of the surface waters in South Africa, a series of monitoring networks are envisaged to assess water quality in rivers, reservoirs, wetlands, estuaries and inshore sea water. Trace metal and organic micro-pollutants will be monitored at selected points within the network.

Microbiological pollutants

Water contaminated by faecal matter is the medium for the spread of diseases such as dysentry, cholera and typhoid. Microbiological data is important for the assessment of fitness for use of water for both drinking and recreation. No systematic programme as yet exists in South Africa for acquiring information about the microbiological quality of either surface or groundwater. As severe localized problems already exist (e.g. in the Mgeni River) a programme of microbiological monitoring is clearly overdue.

Erosion and sedimentation

Average sediment yields for South African catchments range from less than 10 to more than 1 000 tonne/square kilometre/annum. In some parts of the country erosion has increased by as much as tenfold as the result of human impacts.

Viewed by the agricultural sector, soil conservation measures are related mainly to on-site losses (of cultivated lands and natural veld). On the other hand, off-site damages like loss of valuable reservoir storage, sedimentation damage during floods and increased water treatment costs, have been largely ignored even though these are estimated to amount to some R100 million per year. In damage estimates, serious degradation of virtually all estuaries along the Natal coast as well as other environmental damages are seldom considered.

It is evident that intensified efforts are required to quantify soil erosion and sediment transport country-wide and to evaluate the impacts in terms of the national economy.

2.4.2 Groundwater

Although groundwater contributes only about 15 per cent of total water consumption in South Africa, two-thirds of the country, including more than 280 towns and small settlements, mostly in the drier parts, are largely dependent on groundwater.

The importance of groundwater continues to grow even in the wetter parts of the country because of its generally easy availability, cost-effectiveness and the dwindling surface water resources.

An emerging priority is the supply of clean, potable water to developing communities, both urban and rural. The optimal utilisation of local groundwater resources will be crucial in meeting this demand.

It is important to note that the processes of decomposition, absorption, and elimination of substances in groundwater differ fundamentally from those in surface water. Processes are retarded because of the slow movement of pollutants through the groundwater system (by a factor of 1 000 to 100 000 compared with surface water); pollution remains long after the contaminants have entered the groundwater system.

Diffuse as opposed to point source pollution is particularly problematic as it can affect an entire aquifer and can go unnoticed for decades. Once the effects appear it may be necessary to abandon the aquifer. Point source pollution is usually quick to reveal itself and, provided it has not spread too far, can often be corrected.

Because of the lack of systematic monitoring, known cases of groundwater contamination in South Africa are limited. However, this should not give a false sense of security. Within the past decade groundwater contamination has become recognized throughout the world as a major environmental hazard incurring enormous annual expenditure on clean-up and control measures. It is not surprising that some of the strictest environmental control measures have been introduced for groundwater protection.

In South Africa there is an awareness of serious nitrate pollution relating to uncontrolled urbanisation and agricultural practices in large parts of the northern Transvaal and even on the dolomites - the country's most important high-yielding groundwater formation. Another major problem is pollution from mining, in particular coal mining.

Overseas experience suggests that serious problems can be expected to arise from the present rapid urbanisation and associated lack of adequate waste disposal, and in the longer term also from diffuse-source agricultural and atmospheric pollution. Hazardous waste disposal also presents difficult problems.

3. THE PRESENT STATUS OF WATER QUALITY MANAGEMENT IN SOUTH AFRICA

3.1 Structure of Water Affairs

Water quality management is inextricably interwoven with overall water resource management. Quality-related functions are distributed over 17 out of a total of 22 Directorates within the Department, viz: the six Regional Offices, the Hydrological Research Institute, the Directorates of Water Pollution Control, Strategic Planning, Project Planning, Construction, Civil Design, Design Services, Hydrology, Geohydrology, Water Utilization and Law Administration. There is thus within Water Affairs a major widely distributed infrastructure of people, facilities, policies, management information systems and administrative procedures. Water Affairs also participates in liaison organisations with Self-governing Territories and Independent National States, as well as with neighbouring sovereign countries, providing forums for the discussion of both quality and quantity management aspects of shared water resources.

Although not directly involved in the funding of water research, Water Affairs participates actively in the activities of the Water Research Commission, which is the major research funding and co-ordinating organisation in this field. The primary source of the Commission's funds is a levy on water sold by Water Affairs.

The Directorate of Water Pollution Control is geared to fulfil its role of implementing water pollution control legislation. The need to manage water quality rather than only to control point sources of pollution has led, as is indicated later, to the development of the Receiving Water Quality Objectives approach. This will probably be reflected in a change in name of the Directorate of Water Pollution Control to the Directorate of Water Quality. During the past two years six Regional Offices have been upgraded to full directorate level. The Regional Directors now assume responsibility for water quality management through a complement of water pollution control officers under supervision of a Deputy Director : Water Quality. The Directorate in Pretoria develops policy, advises and monitors the Regional Offices with regard to compliance with policy. It also maintains a management information system for pollution control. As with many of its other functions, Water Affairs has difficulty in attracting sufficient suitably qualified staff for water pollution control. During the 1991/92 financial year, Water Affairs will probably spend up to R11.4 million on water pollution control, not counting the R4 million to be spent on the rehabilitation of abandoned coal mines.

Extensive use is made of consultants from organisations such as the CSIR, universities and consulting engineering firms.

3.2 Definition of water quality management and the role of water pollution control

Water quality management embraces decisions and actions which lead to the development, implementation and execution of strategies to achieve the stated mission and objectives. These activities are outlined below.

Planning

The adequate planning of water resources development involves, inter alia: investigations into demands, impacts associated with meeting demands, devising of effective strategies, objectives, policies and actions - both structural (physical works) and non-structural (legislation). From the water quality point of view such actions entail locating and quantifying pollution discharges from a wide variety of sources as well as prediction of future levels of pollution and study of the effects of pollution on the ecology in its widest sense. Such activities as establishing minimum discharges to sustain aquatic biota and wild life, effects of sedimentation and general control of water require careful planning inputs and all demand attention to the interplay of external factors such as socio-economics, politics and the environment in general.

Comprehensive studies, research and monitoring

These all demand funds, time and skilled manpower.

Co-ordination and communication

Effective co-ordination and communication is vital, in view of the interrelationships and interdependence of land and water systems and the wide range of organisations, authorities and public involved.

Education and training

The increasing complexity of water systems and quality control technology, underlines the pressing demand for skilled manpower.

Organisation

The creation of effective teams that encompass the wide variety of skills associated with water quality management requires good organisation.

Decision-making

Comprehensive guidelines are needed to reach balanced decisions as to what is acceptable, to establish regulatory requirements and to determine responsibilities. Personnel adept at the fair use of discretionary powers are required for this task.

Regulation, operation and control

Water pollution control constitutes an integral part of water quality management and is dealt with extensively in this report.

Monitoring and evaluating success

Constant monitoring of the extent to which objectives have been successfully achieved is fundamental to good management.

Information

The establishment and maintenance of a dynamic information system is vital to successful water quality management. A free flow of information concerning all aspects of water, water use and demand is essential.

The quality of a water resource may be managed by using either one or a combination of two fundamental strategies, namely, treatment of the symptoms and/or control over the causes of water quality problems. Familiar examples of these strategies are:

- when raw water which does not meet quality requirements is treated before domestic or industrial use, or when good quality water stored in a reservoir is released for blending with poor quality water to yield a larger volume of water of acceptable quality this constitutes treatment of the symptoms of the problem; and

- when pollution of water resources is controlled or prevented, i.e. controlling the causes of water quality problems.

Water pollution control therefore constitutes an integral, and often the most important, part of any water quality management system.

Many functions of Water Affairs are aimed in one way or another at treating the symptoms or preventing the causes of water quality problems. Some of these are listed here:

- Strategic planning for water quality management.
- Development and implementation of water quality management plans and monitoring systems for river catchments.
- Control over effluent disposal and monitoring of compliance.
- Control over industrial water use.
- Control over pollution of the coastal marine environment from land based pollution sources.
- Control over waste disposal sites on land.
- Registration of water care works and operators.
- Provision of subsidies for sewage treatment works.
- Control over river deviations.
- Rehabilitation of sources of pollution, such as abandoned coal mines.
- Control over hazardous pollutants.
- Operation of water supply schemes for quality improvement purposes.
- Operation of a national water quality monitoring system.
- Operation of emergency responses to water pollution incidents.
- Training of staff involved in water quality management.
- Provision of a water pollution control management information system.
- Maintenance and administration of legislation and regulations for statutory and non-statutory water quality management.
- Liaison with the public in connection with water quality management issues.

3.3 The overall goal of water quality management

A review of water quality management in many different countries revealed really only two desirable goals namely, either -

- to maintain water quality in some original or pristine state; or
- to maintain water quality in such a state that it remains fit for recognised uses.

According to Section 23 of the Water Act it is an offence to pollute water by rendering it less fit for -

- the purposes to which it could ordinarily be put to use by other persons;
- the propagation of fish or other aquatic life;
- recreation or other legitimate purposes.

Section 23 forms the basis of Water Affairs' mission with regard to water quality management. It states that Water Affairs "should ensure that water of acceptable quality continues to be available for recognised water uses, such as urban, industrial, agricultural, recreational and environmental conservation uses". It is important to note that the Water Act, in common with water pollution control legislation in most developed countries in the world, does not require Water Affairs to ensure that the quality of South Africa's marine and freshwater resources remain in some original or pristine state unless this can be justified in terms of maintaining such quality for the purpose of meeting the requirements of one of the recognised water uses.

The concept of zero pollution is neither required nor implied in the Water Act. On the contrary, because South Africa is a water scarce region, re-used effluents are considered vitally important supplements to freshwater resources. Purified effluents, with their accompanying pollutants, are required to be returned to the natural water bodies for re-use.

The concept of fitness for use implies an evaluation of water quality in terms of the requirements of a particular user or category of users and is measured in relation to criteria or norms representing ideal quality for a particular use. It is necessary to view the fitness for use concept as one where the overall risk to the consumer or environment is minimised, and the risk or the required level of protection is defined.

There are various degrees of fitness for use but no sharp distinction between water one hundred percent fit for use (no risk) and water completely unfit for a particular use (unacceptable risk). Between these extremes there is a wide transition zone in which water quality may, to an acceptable degree, be fit for a particular use.

Fitness needs not relate only to quality, e.g. the concentration of a particular substance in the water. It may also relate to the timing and duration of the concentration of that substance in water. For example, some crops are sensitive to high salinity only during the seedling stage or only if exposure to highly saline water is prolonged. Thus water may be fit for use for a certain percentage of the time.

It is therefore emphasised that the fitness for use concept does not demand that water quality requirements be stated in absolute terms but may vary according to the particular use or category of uses or acceptable level of risk. For certain uses, water quality criteria or guidelines would in fact demand zero risk.

3.4 Factors affecting water quality management

Several important factors have a bearing on water quality management. Some that are referred to here may also dictate water quality management strategy:

- South Africa is a semi-arid country with limited water resources. Two previous commissions of inquiry into water matters concluded that the re-use of effluent would have to play a vital role in reconciling water supply with demand.

- Economically South Africa has a unique mixture of undeveloped, developing and developed components. This places some constraints on the options available for resource protection. It is sometimes argued that, because of their need for economic development to improve standards of living, developing countries cannot afford to place the same priority on environmental protection as developed countries do.

- As indicated earlier, water resources in South Africa are distributed unevenly. In the water-rich parts the need to return effluent to the original source of the water may not be as pressing as in the more arid parts of the country where the return of effluent may be crucial for matching water supply with demand.

- Serious shortages of skilled manpower are being experienced, especially in the public sector, and all indications are that this situation is likely to persist. This places severe constraints on decision-making systems and levels of information required to support the decision-making processes.

- South Africa is in the process of undergoing fundamental political, social, economic and constitutional changes which may drastically alter the present dispensation regarding water quality management. At the same time, the whole environmental management system is under review. Under circumstances in which virtually all socio-political systems are in such a state of flux it is difficult to conceive appropriate structures for implementing strongly consultative decision-making processes.

3.5 Fundamental approaches to water pollution control

Control over sources of water pollution is central to water quality management. Every country in the world has its own unique approaches to water pollution control but generally they are variations and/or combinations of a few fundamental approaches, namely the Uniform Effluent Standards Approach, the Receiving Water Quality Objectives Approach and the Pollution Prevention Approach. Each of these will be briefly discussed.

Uniform effluent standards

The Uniform Effluent Standards approach aims to control the input of pollutants to the water environment by requiring that effluents comply with uniform standards. The underlying philosophy is that minimum pollution (from point sources) is the desirable ultimate goal.

Accordingly, these uniform standards should be set so as to achieve levels of effluent pollutant concentration that would result from applying "best available technology not entailing excessive cost". Aspects of this approach have been adopted by the European Community in the past and have formed the basis of pollution control activities by Water Affairs.

The approach, however, has several drawbacks:

- It is focused on effluent and effluent treatment technology and largely ignores the impact on the quality of the receiving waters

- Where there are multiple point sources or high background levels of pollution arising from diffuse sources, application of Uniform Effluent Standards may fail to protect the quality of water resources

- The approach is also not necessarily cost-effective because it requires all effluent to comply with the same standards, irrespective of variations in the assimilative capacity of the receiving waters and regardless of the costs involved

- There is no incentive for industry to locate at the most environmentally advantageous location

- It provides no framework for control of non-point sources and consequently cannot guarantee that quality objectives in receiving waters will continue to be met.

There are, however, two main advantages:

- It is simple, understandable and straightforward to enforce.

- Frequent updating of the standards to incorporate the latest and best pollution abatement technology should have the effect of minimizing pollution from point sources.

Receiving water quality objectives approach

The Receiving Water Quality Objectives approach involves specification of the desired quality of the receiving water environment and the control of sources. The approach takes into account non-point and point sources of pollution to the degree necessary to maintain the desired quality. This approach recognises that the receiving water has a certain capacity to assimilate pollution without serious detriment to quality requirements of recognised users. By setting site-specific effluent standards that take into account the contribution of diffuse sources of pollution, point source pollution can be effectively controlled.

There are three major advantages:

- With the focus on the quality of receiving waters and minimum interference with legitimate uses of the environment, account has to be taken of both point and non-point sources of pollution.
- It is cost-effective because, by considering the capacity of the receiving water environment to assimilate particular pollutants, it optimizes the level of control required.
- It offers an incentive for industry to locate where the receiving environment is least sensitive to pollution.

Drawbacks from the regulatory point of view are -

- application is technologically more demanding because thorough understanding is needed of the fate of pollutants and of their impacts on the water environment;
- site-specific effluent standards have to be specified, and this requires considerably more detailed investigation than the application of the Uniform Effluent Standards approach.

Pollution prevention approach

The Pollution Prevention approach is aimed specifically at control of the handling and disposal of hazardous substances. Toxicity, persistence and capacity for bio-accumulation present major threats to the environment.

In this domain, the Receiving Water Quality Objectives approach is inappropriate because of the difficulty of setting safe receiving water quality standards for these pollutants coal-mining areas of the eastern Transvaal and northern Natal acid drainage and sulphate pollution have caused widespread problems.

To counter water quality deterioration and to adapt to the social, economic and political changes taking place in South Africa, Water Affairs has re-evaluated and adapted its approach to water pollution control. The changes are listed here:

- It is accepted that the water environment has a certain capacity, usually quantifiable, to assimilate non-hazardous pollutants without detriment to predetermined quality objectives. This assimilative capacity is considered to be part of the water resource and must be judiciously managed and equitably shared by all water users for disposal of their wastes.

- For hazardous pollutants which pose severe threats to the environment because of toxicity, persistence and extent of bio-accumulation, a precautionary approach should be adopted aimed at minimizing or preventing entry of such substances to the water environment.

- Water Affairs has therefore adopted the Receiving Water Quality Objectives approach for non-hazardous substances and the Pollution Prevention approach for hazardous substances.

These two relatively new approaches to water pollution control, is being implemented gradually and jointly phased in to replace the Uniform Effluent Standards approach. Nevertheless, if the precautionary approach to environmental protection is to be adopted, some kind of minimum (in place of uniform) effluent standard will have to replace the present General and Special Standards.

As at present applied in South Africa, the Receiving Water Quality Objectives approach involves -

- the compilation of water quality guidelines based on the requirements of the recognised water uses;

- formulation of water quality management objectives which recognise the water quality requirements of water users as well as economic, social, political, legal and technological considerations (the management objectives therefore do not necessarily conform to the water quality guidelines); and

- imposition of site-specific effluent standards or other measures to ensure that the water quality management objectives determined for the particular water body will be met.

Fundamental to the Receiving Water Quality Objectives approach is the determination of the quantity and quality requirements of the different user sectors. Normally Water Affairs would depend on the user to state its requirements.

The Pollution Prevention approach involves source reduction and recycling to reduce the quantity and/or toxity of waste and to minimize present and future threats posed by hazardous substances to human health and to the environment.

3.7 Status of groundwater quality management

Being largely a localised resource and classed as private water in the Water Act, groundwater has received sparse attention from the point of view of policy development. Classification of groundwater as private water creates a number of complications for groundwater management:

- Groundwater and surface water are hydrologically connected and it is difficult to separate them either legally or administratively. Integrated management of all water resources has thus been complicated through the legal separation of waters.

- Except in specially declared Subterranean Government Water Control Areas abstraction of private water is subject to no control. The Water Act provides no protection to a user through abuse by other users, e.g. overpumping.

- Obtaining data on groundwater resources from individuals or companies is complicated because it is classified as private water. The information is regarded as confidential.

- Although section 22 of the Water Act states explicitly that water pollution prevention relates to both public and private underground and surface water Water Affairs' role in implementing the protection of localised private water has not been spelled out.

The emphasis has recently shifted from local groundwater development to regional characterization and optimal management of groundwater resources. The resulting information base will doubtlessly facilitate improved groundwater management and implementation of enhanced policy formulation on quality aspects.

3.8 Review and evaluation of South Africa's approach to water pollution control

The combined Receiving Water Quality Objectives and Pollution Prevention approach has been applied for the past two years, during which it has been found that only the Receiving Water Quality Objectives aspect has received meaningful attention. Considerable experience has been built up in conducting the waste load allocation investigations that are central to the application of Receiving Water Quality Objectives approach. In principle, this involves assignment of allowable discharges in such a way that the water quality objectives for the designated water uses can be met. It requires determination of water quality objectives for desirable water uses, understanding of the relationship between pollutant loads and water quality and use of these to predict the impacts on the water environment as well as the economic impacts and socio-political constraints. The benefit/cost relationship is also analysed.

The Receiving Water Quality Objectives approach has so far been applied mainly where polluters have approached Water Affairs for relaxation of the General or Special Standards. Although the Receiving Water Quality Objectives approach may well result in site-specific standards that are stricter than the General and Special Standards, the experience so far has been that investigations have in all cases resulted in relaxation of the requirements. There can be no doubt that the new approach has considerably facilitated decision-making and has generally been favourably received both by industry and local authorities that have to comply and by those concerned with protection of the environment. Both groups have perceived the Receiving Water Quality Objectives approach to be a rational process for reaching decisions on pollution control.

Despite the general acceptance, however, there has been some concern about the fact that the approach does not call for some minimum level of effluent treatment. On the other hand minimum requirements are implied in the General and Special Effluent Standards which are relaxed only when justified on the basis of the Receiving Water Quality Objectives approach or on technological and/or economic grounds.

In effect, Receiving Water Quality Objectives as applied by Water Affairs amounts to a policy that can be formulated thus:

- Effluent producers have to comply with minimum effluent standards, namely the uniform General and Special Effluent Standards. If satisfactorily motivated on technological and/or economic grounds and justified by the Receiving Water Quality Objectives approach, exemptions to the Standards may be granted by substituting site-specific effluent standards. This policy also makes provision for site-specific standards that may be stricter than the General and Special Effluent Standards.

The receiving water environment includes the marine environment. It is accepted that the marine environment has a quantifiable capacity to assimilate pollutants without detrimental effect or health risk. Moreover, the skills exist in South Africa to evaluate and design marine outfalls to comply with quality requirements.

Water Affairs has in fact been applying the Receiving Water Quality Objectives approach to control pollution of the marine environment much longer than for inland water bodies. In terms of the Water Act, marine disposal of effluent arising from water sources other than the sea is prohibited unless an exemption has been granted by the Minister. From health risk, environmental conservation and economic points of view, disposal of effluent to sea in coastal regions is often the most desirable option.

It is Water Affairs' contention that sound water quality management would be best served if industries that produce large volumes of saline effluent were to be situated at the coast so that they might discharge their effluents to the sea rather than contaminate the limited freshwater resources of the interior.

Application of the Receiving Water Quality Objectives approach to marine pollution control involves establishing quality criteria for each of the beneficial uses of the marine environment. Beneficial uses include bathing, fishing, shellfish gathering, industrial use and conservation of the marine environment. Special attention is paid to human health risk and protection of the marine environment. Before an exemption is granted to discharge effluent to the sea, Water Affairs must be assured that the outfall design is such that sea-water quality management objectives will be met. A permit specifies conditions for comprehensive monitoring of the marine environment in the vicinity of the outfall. To date, monitoring has shown few, if any, detrimental ecological impacts associated with sea outfalls.

Recent experience, however, shows that public opinion is strongly opposed to marine outfalls in general. Steps will have to be taken to inform the public fully and to seek wide public involvement before permits are granted.

Although sea outfalls are adequately controlled more and more problems are arising due to stormwater discharges from urban developments along the coast. Investigations are currently being conducted to develop guidelines for remedial and preventive measures.

4. STRATEGIES THAT AFFECT WATER QUALITY MANAGEMENT

Although the primary goal of managing water quality is to maintain fitness for use, there are other water resource management policies and strategies that impact on water quality. To appreciate these impacts it is important that the interrelationships of these policies and strategies are understood. They are briefly described here.

4.1 Reconciling water demand and supply

As was indicated earlier, re-use of effluent plays an important role in matching water supply and demand. The Water Act of 1956 therefore made it compulsory for effluent to be treated to specified standards and disposed of in a manner that would make it available for re-use. Re-use of effluent must continue to play a major role in the national water budget. As quality and quantity aspects of water resources management are so inextricably interwoven in South Africa, both the quantity and the quality aspects of water resources management are the responsibility of a single authority. It follows that, as long as re-use of effluent continues to play a major role in reconciling water supply and demand in South Africa, water quality management, including water pollution control, cannot be divorced from water supply management.

In view of the many complex and dynamic technical, legal, social and economic issues associated with the direct re-use of water, Water Affairs' policy is to give preference to indirect re-use by requiring effluent, after treatment, to be returned to the natural water body from which the water was drawn.

Projected runoff from the Hartbeespoort Dam catchment provides an example of the important role of effluents and stormwater runoff from urban areas in the development of the water resources of a region. Annual runoffs to the dam, projected from the present to the year 2020, are shown in the following table.

Projected annual runoff to Hartbeespoort Dam, present and future

	1990	2000	2010	2020
SOURCE		Million cubic metres per annum		
Natural runoff	177	177	177	177
Urban stormwater runoff	29	46	65	85
Effluent	100	177	257	335
Upstream irrigation	-41	-50	-62	-74
TOTAL	265	350	437	523

Note that effluent return flows will soon contribute as much as the natural runoff and by the year 2020 will be double the natural runoff. In fact by the year 2020 stormwater runoff from urbanised areas will be half as much as natural runoff. These huge quantities of effluent and stormwater runoff can be utilised properly only if they are accepted as being an integral part of the total water resource and if their quality is adequately managed. By the same token, however, it would be quite unrealistic to think that the quality of the water in the Crocodile River basin could be rehabilitated to its original pristine state of a few hundred years ago.

4.2 Reconciling water quality protection with financial goals

Economic development should not take place at the expense of environmental degradation. However, sustained economic development is a prerequisite to achieving other national goals which include the ability to afford protection of the environment. Water Affairs adopts a holistic approach to conservation of resources, which includes the country's capital resources.

It is sometimes not financially or even technologically feasible to reduce pollution to a level required to ensure adequate protection of the environment. In such cases, Water Affairs has to seek trade-offs between water quality objectives and the financial objectives of not only the polluter but also of the region of origin of the pollution and of the country as a whole. Consequently individual, regional and national financial objectives are important considerations in reaching water quality management and pollution control decisions.

Environmental and financial issues are becoming increasingly complex. Nevertheless justification of limited environmental degradation on the basis of financial considerations is rapidly becoming unacceptable.

4.3 Command-and-control approach to water quality management

Along with many other countries, Water Affairs uses the command-and-control approach to meet its responsibilities of managing water quality and controlling water pollution. The approach involves specification of environmental and/or emission standards, often also the waste treatment technology to be used, and the behaviour of waste producers. The control authority is then responsible for instituting and maintaining elaborate legal and administrative systems to ensure compliance. The Water Act of 1956 and later amendments, notably the Water Amendment Act of 1984, vested wide and seemingly adequate powers in the State to control industrial use of water and to control or prevent pollution from both point and non-point sources. Requirements concerning certain actions are laid down in Sections 12, 12A, 12B, 21, 22, 23, 23A, 24 and 26 of the Act and are listed below:

- Control of the quality, use and re-use of effluent, and the manner and place of disposal.
- Control of the quantity of water used for industrial purposes.
- Control of the erection, enlargement and registration of water care works.
- Control of pollution of surface and groundwater through stormwater runoff or seepage.
- Steps required to be taken by polluters to prevent or control pollution. In certain cases Water Affairs may take the necessary steps to recover the cost from the responsible person or organisation.
- Control of the manufacture, use or marketing of substances which might cause pollution.
- Submission of information relating to water pollution control to Water Affairs.
- Relaxation of or exemptions from the requirements of the Water Act or Regulations.

It is generally acknowledged that strict regulations and controls are absolutely essential for the protection of the environment. In both the United States and the European Economic Community there is a strong direct relationship between per capita wastewater treatment and the degree of regulation.

4.4 Public involvement in decision-making

In South Africa, as elsewhere in the world, the general public has recently shown increased concern for the environment and how it is being managed by the authorities. In its application of a uniform effluent standard approach in the past, Water Affairs possibly gave inadequate attention to the receiving water quality with the result that formal negotiations on deviations from the uniform standards usually involved only the polluter and Water Affairs. The present approach focuses on the quality of the receiving water body with the consequence that water users can enter into negotiations regarding quality requirements.

Public involvement is particularly important both at the policy and at the operational level of groundwater management because of the private nature of groundwater.

Water Affairs appreciates and welcomes the public's interest and active involvement in the management of the country's water resources and seeks to involve the public as far as practically possible in decisions regarding water quality management. Its policy towards public involvement therefore may be stated thus:

- Water Affairs acknowledges that the general public should be involved in decisions concerning guidelines for the quality of receiving waters and water quality management objectives. However, the determination of appropriate, site-specific pollution control measures and the issuing of permits remain matters to be settled between Water Affairs and the polluter without involvement of the public. The public will nevertheless be kept informed on the extent to which the Receiving Water Quality Objectives are being met.

Where Water Affairs and the public cannot reach agreement on water quality guidelines or management objectives for a particular water body, the policy is that -

- Cases in which consensus about receiving water quality guidelines or objectives cannot be reached between Water Affairs and the public involved, should be referred to the Minister of Water Affairs who, if he so wishes, may obtain an independent opinion, but he shall have the final say.

Policies involving the public in certain aspects of decision-making in water quality management are fairly new and have been applied only in a few cases. As public perceptions, particularly concerning the safety of water for drinking and recreational purposes, demand increasing attention, public involvement will become more common. People are no longer as willing to accept official or scientific assurances, despite all the technological tools used to determine the facts and reality. Public perception has become the overriding reality and all those involved in water quality management will have to accept this and learn to deal with it.

4.5 The polluter pays principle

Water Affairs' policy in this respect is that:

- in general, the principle of Polluter Pays applies, but there are cases where the polluter cannot be held accountable whereupon the principle of public responsibility applies.

This policy implies that an owner seeking an exemption permit must also carry as much of the cost of the investigation as is practicable. In the case of waste load allocation, where it is practically possible, the polluter is expected to carry the cost of the investigation required by the Receiving Water Quality Objectives approach. Where permits have been issued and compliance with permit conditions has to be monitored on an ongoing basis, the polluter is responsible for the monitoring and has to submit the results to Water Affairs. Water Affairs is responsible for auditing the polluter's monitoring results.

Examples of cases where the polluter pays principle cannot be applied are where mines were closed before the promulgation of the Water Act in 1956, or mines of which the owners cannot be traced. In such cases Water Affairs has had to assume responsibility for rehabilitating the sources of pollution. In 1987 Parliament approved a plan to spend R32 million to combat water pollution associated with abandoned coal mining operations. These funds are currently being spent by Water Affairs at the rate of R4 million per annum. To date, six abandoned coal mines have been rehabilitated and work is in progress at two others. The completed work has already resulted in major improvements to downstream water quality.

Continued application of the polluter pays principle becomes problematical when approaches other than command-and-control are used to achieve water quality objectives. Examples would be the use of economic incentives or the provision of advisory and/or technology transfer services to industry to promote pollution prevention and waste minimization principles. One way to overcome the difficulty of making the polluter pays principle work in cases like these, is to use funds generated from sources such as effluent charges so as to at least partially finance the pollution control function of the State.

Water Affairs will continue to retain the polluter pays principle during the development and/or modification of other water quality management policies and strategies. In the case of groundwater the principle needs further development. Groundwater contamination processes are invisible and slow and the impacts are long-term. Groundwater protection is a far less expensive process than rehabilitation but protection should not be perceived as an isolated action, it must be part of a long-term Water Affairs' programme. Ways must be found to allocate the cost of the protection programme to the individual polluter or pollution sector rather than to the general taxpayer.

4.6 Prosecution of offenders

The Water Act of 1956 makes provision for prosecuting those who do not comply with its provisions or the promulgated regulations. The maximum penalty for a first offender is R50 000 and/or one year's imprisonment. For second offenders it is R100 000 and/or one year's imprisonment. The court also has the right to impose an additional penalty equal to the benefit gained by the offender through not complying with the Act or the Regulations (Section 171 of the Act).

Water Affairs policy regarding powers to prosecute offenders is that -

- much better results are achieved by using a co-operative rather than a confrontational approach and that charges should be laid only as a last resort where the offender wilfully and/or negligently violates the requirements of the Water Act and is clearly unwilling to take the necessary steps to comply.

At present the decision as to whether or not to institute legal steps is left to the discretion of the individual water pollution officer or his superior. One of the results of increased environmental awareness is that the general public holds government departments accountable to a much greater degree than before for their actions in the environmental protection arena. An unfortunate consequence of this is that the ability of pollution control staff to exercise judgement in deciding when or when not to prosecute is severely limited. In cases where Water Affairs officials have decided not to prosecute offenders this has sometimes been perceived as either collusion with polluters or the dereliction of duty.

Violations of the Water Act are at present prosecuted as criminal offences only. The Act also specifies maximum fines. No provision exists for civil action in which, for example, damages might be claimed from someone who has caused damage by polluting the natural water body.

Water Affairs plans to maintain a co-operative approach as its policy and to seek prosecution only as a last resort in the firm belief that this approach achieves the best results, measured in terms of water quality improvement.

The intention is to develop a systematic decision-making framework that will guide pollution control officers in deciding when to prosecute offenders. This will be accessible to the general public and must be clear and easily understood.

Because of widespread ignorance about groundwater and the difficulties of monitoring, liability is almost impossible to prove. Complementary strategies such as pollution source controls coupled with the education of those involved with the use and development of groundwater, are therefore required.

4.7 Interpretation of water quality in probabilistic terms

Water quality is highly variable. Many factors, some unknown and many random, affect water quality, and precise measurements are not possible. This applies as much to the quality of natural waters as to the quality of effluents. Because the causes of random variability are not known they are usually impossible to control. If, for instance, both natural water quality and effluent quality are highly variable it becomes unrealistic and/or unfair to set absolute water quality objectives or effluent standards.

Water Affairs has therefore adopted the policy of expressing water quality guidelines and management objectives in probabilistic terms. For example, expressed in absolute terms, the limitation of fluoride concentration (F) in water for potable use would be -

- the concentration in the water must be less than or equal to 1 milligram F/litre (implying that all observations made over any specific period must show F concentrations equal to or less than this value).

In probabilistic terms Water Affairs would specify that -

- the F concentration in the water must be less than or equal to 1 milligram F/litre for 95 percent of the time (implying that 95 percent of the observations made over a specific period must show F concentration less than or equal to 1 milligram F/litre).

Two important problems arise when effluent standards are stated in probabilistic terms.

- It could be argued that by allowing effluent quality to exceed the specified standards for five per cent of the time creates the opportunity for effluent producers to "dump" wastes. This argument presupposes that effluent producers have the means to store wastes in one way or another and to then legally discharge effluent containing very high concentrations of the waste product during the five per cent of time they are allowed to exceed the standard. Although many investigations have shown that this way of dumping is not technically feasible for the vast majority of waste water treatment plants, it still remains a major concern in the eyes of the general public. This problem can be overcome by stating an absolute upper limit for effluent quality in conjunction with the probabilistic standard.

- A more serious problem in specifying effluent standards in probabilistic terms is that this can create major legal problems in the interpretation of what constitutes a violation when someone is prosecuted. Because of legal implications, care should be taken when formally stating effluent standards in probabilistic terms.

Water Affairs has nevertheless decided to adopt the policy of interpreting effluent standards in probabilistic terms. To overcome legal interpretation problems of probabilistic standards, effluent standards will be stated in absolute terms in the permits but compliance will be assessed on a probabilistic basis.

5. WATER QUALITY MANAGEMENT: EVOLUTION OF POLICY

5.1 Principle of Anticipatory Environmental Protection

The principle of anticipatory environmental protection has received much attention in environmental policy development during the past decade. Two of many definitions are mentioned here:

- In principle, anticipatory environmental protection encompasses all positive actions to avert danger or minimise risk to the environment, and to protect and develop the natural basis of existence.

- It is an obligation, akin to a statutory duty, to anticipate probable impacts of pollution on health, resources, and the environment. The object is not simply to avoid problems but to plan to gain environmental and economic benefits from all the opportunities offered.

The principle has some important implications:

- Avoiding or reducing risks threatening the environment by gradually reducing emission levels of all possible harmful substances introduced by man into the environment, even though there may be no scientific proof that existing levels of emission are causing harm to the environment. It involves adopting the best available technology to control pollution. The approach requires polluters to implement specified minimum levels of technology of waste treatment.

- Promoting conservation and efficient use of resources to reduce, as far as possible, the requirement to develop new resources such as energy, water, minerals, etc., thus avoiding the need for additional investment in new resource development projects. For example, by protecting the capacity of the water environment to assimilate wastes, the need to develop new or additional water supply schemes can be avoided or at least postponed.

- Preference is given to controlling the causes of pollution rather than treating the symptoms of it.

Experience elsewhere in the world has shown that, operationally, neither the Receiving Water Quality Objectives approach nor the Uniform Effluent Standards approach to water pollution control are fully effective. Although the new approach is aimed at maintaining the quality of the water environment to meet the requirements of water users, the need to anticipate environmental hazard is not adequately addressed. Many countries, e.g. the United Kingdom and Japan, have therefore opted for a dual system in which the Receiving Water Quality Objectives approach and Uniform Effluent Standards approache have been combined.

In this combined approach, minimum effluent standards (these could be national, regional or industry-related, or limited to introduction of certain compounds) specify the minimum requirements for effluent treatment before it would be allowed to dispose waste in the environment. The Receiving Water Quality Objectives approach is used merely to justify the introduction of stricter standards in cases where the minimum standards are insufficient to ensure adequate protection of the receiving environment.

The important difference between the Receiving Water Quality Objectives approach as applied in South Africa and in other countries is that here it has so far been used exclusively to justify exemptions from compliance with minimum effluent standards. In other countries it is used only to justify the introduction of stricter than minimum standards.

The difference mainly concerns what is understood by minimum effluent treatment standards.

For the United States Environmental Protection Agency these are industry-related minimum effluent standards based on the economical and technological feasibility of treating effluent emanating from specific industries. These minimum standards even take account of the age of the industrial plant, i.e. whether it is a new plant being constructed, in which case modern effluent treatment technology can be applied, or an old, established plant in which there has been a commitment to a specific effluent treatment technology.

In South Africa it was decided to adopt the existing General and Special Effluent Standards as the minimum effluent treatment requirement. These standards were previously used as part of the Uniform Effluent Standards approach to state the quality requirements with which all effluents had to comply, regardless of source or point of discharge. For certain constituents in the General and Special Effluent Standard, i.e. those which were based on Best Available Technology, the standards can be considered to be minimum requirements for the treatment of specific types of effluent. However, standards for other constituents were based on the quality requirements of water users and were not at all related to economic or technological feasibility of effluent treatment. These cannot therefore be considered as statements of minimum treatment required but rather as water quality guidelines for the receiving waters. It was for this reason that the Water Act made provision for exemptions to be granted where these could be motivated, mostly on the basis of technological and/or economic considerations. It is vital that the role of effluent standards, water quality guidelines and water quality objectives be thoroughly reviewed and clarified to remove any uncertainty surrounding the concepts of Receiving Water Quality Objectives approach.

Because the anticipatory or precautionary principle is so important in environmental protection, Water Affairs aims to include some such aspects in its water quality management policies.

5.2 Integration of water quality management with national environmental management policies.

To take proper account of the effects of pollution control measures on all the environmental media, the United Kingdom Royal Commission on Environmental Pollution, in its 12th report, defined the Best Practical Environmental Option approach as the outcome of a systematic, consultative and decision-making procedure which emphasised the protection of the air, land and water environment. The procedure establishes, for a given set of objectives, the most beneficial option with least damage to the environment as a whole , at acceptable cost in the long term as well as the short term. The Best Practical Environmental Option is in fact very similar to the Integrated Environmental Management protocol developed by the South African Council for the Environment.

Water Affairs' custodianship of South Africa's water resources stands largely independent of the Government's role as custodian of the environment as a whole. Its goal of maintaining fitness for use of South Africa's water resources does not specifically demand consideration of the impact of its decisions on other environmental media. In implementing its water quality management policies and strategies, Water Affairs concentrates on water environment impacts.

There are many exceptions to the policy of limiting the responsibility of Water Affairs to the water environment. In the broader environment, Water Affairs has involved other organisations, such as the Department of Environment Affairs and the Provincial Nature Conservation Departments in investigations of and decisions concerning options for effluent disposal. However, decisions on whether or not to consider the larger environment and whom to involve, were invariably made on an ad hoc basis.

Water Affairs' present policy of selecting the best practical water quality rather than environmental option inhibits the proper linkage of water resources management with the more comprehensive environmental management.

Unfortunately, it is not simply a matter of switching to the selection of the best practical environmental option, because implementing this would present major problems to Water Affairs under present circumstances. Several of these relate to the highly fragmented nature of environmental management in South Africa.

- A multitude of organisations, at various levels of Government, would have to be involved in the water quality management decision-making process. There is at present no convenient structure for involving all these organisations. Without such a structure, involvement could severely retard the decision-making process.

- There are no common overall objectives for the management of the different environmental media. For example, it seems that the overall goal of air pollution legislation is to ensure that the best practical means are used to control pollution whereas the

- overall goal stated in the Water Act is to maintain the fitness for use of South Africa's water resources. If the overall objectives for the management of the different environmental media differ, implementation of the principle of best practical environmental option would be impossible.

It seems that with the promulgation of the Environment Conservation Act of 1989 a legal framework for adopting the best practical environmental option has now been created. Part 5 of the Act makes provision for the control of activities which may have a detrimental effect on the environment. Provision is made for water use and disposal to be identified as one such activity. The Act makes provision that if an activity has been identified, authorisation to implement it will be given only once consideration has been given to the impact of that activity on the environment.

A lack of co-ordination between environmental and water authorities has been identified worldwide as one of the most serious and damaging institutional failures. It is caused by conflicting and contradictory policies in water resources and environmental management. It is recommended that for the present Water Affairs should continue its policy of selecting the best practical water quality, rather than the environmental, option but should investigate the feasibility of broadening its policy through considering the overall environmental impact of its actions in water quality decision-making. Such an investigation should be co-ordinated with those presently being conducted by the President's Council and the Department of Environment Affairs.

5.3 Incentive-based measures for environmental protection

There is a growing trend towards employing several alternatives to the command-and-control approach in order to achieve adequate levels of environmental protection. One of the important reasons for seeking alternatives is that the cost of adopting current water quality management policies often substantially outweighs the benefits. In a study by the Organization for Economic Co-ordination and Development the need was emphasized to establish the right mix of regulations and incentives. Planning, fiscal and economic instruments should be co-ordinated with regulatory measures so that regulation becomes less punitive and more incentive-based with resulting cost minimization while innovation in technology and management is encouraged.

It was suggested that one way to improve the benefit-cost relationship in the existing policy would be to seek more cost-effective means of achieving given water quality objectives. These alternatives include the use of economic incentives, market forces and the provision of information and technology transfer services to industry.

The United States Environmental Protection Agency found that when it adopted pollution prevention as the first choice option for environmental protection it had to adopt a co-operative non-confrontational approach to industry. The need for setting specific mandatory standards for waste minimization was rejected on the grounds that:

- it would interfere with industry's production decisions and thereby possibly be counterproductive

- such standards would be difficult and expensive to design and administer

- waste generators are already facing strong economic incentives to reduce their wastes.

The Environmental Protection Agency also found that the adoption of the pollution prevention approach required that they become involved in providing an advisory service to industry which entailed the provision of information, technology evaluation and technology transfer.

The capacity of a water body to assimilate or dilute wastes represents a real economic value when the cost of water quality impacts are considered. Therefore, there is a worldwide trend towards the use of economic incentives or market forces to supplement and support the regulatory power of governments to ensure adequate environmental protection. Economic-incentive approaches ensure that pollution control efforts are in the financial interests of polluters, as long as the cost of pollution control is sufficiently low. Hence these mechanisms provide ongoing incentives for polluters to develop and adopt newer, better and cheaper pollution control technologies. Although it is generally agreed that there will always have to be regulatory control to protect the environment, the use of economic incentives or market forces is gaining importance as an adjunct to direct regulation of pollution sources. Recently, countries such as Poland and the USSR have either adopted or proposed the adoption of economic incentives to support existing environmental protection measures.

In a recent report produced by the Organization for Economic Co-ordination and Development, the practical experiences of 14 countries were reviewed. Included were economic measures or incentives, such as charges or taxes on effluent, user and product charges, tax relief and subsidies for anti-pollution investments and trading of pollution rights. Problems of enforcement and implications of the polluter-pays principle were also discussed. In an assessment of federal water pollution control policies of the United States it was concluded that attainment of water quality objectives had been slow, timetables had not been kept and deadlines specified in the legislation had not been met. A major share of the blame for the slow progress was attributed to the inappropriate incentive structure created by the regulatory approach whereas economic incentives would have been more effective.

The following economic incentive mechanisms have been proposed:

Pollution Charges

These systems impose a fee or tax on the pollution load. Consequently, it pays to reduce pollution to the point where the marginal cost of pollution control is equal to the pollution tax rate. Different polluters end up controlling different amounts of pollution, the high-cost controller controls less and the low-cost controller controls more, but all tend to experience the same marginal cost of pollution control. Examples of water pollution charges are found in several western European countries, e.g. France, the Netherlands and Germany and it is planned to introduce it in the USSR. A disadvantage of the pollution charge system is that the authorities imposing it do not know in advance what level of environmental protection will result from a given charge.

Marketable Permit System

Under the tradable permits system the allowable overall level of pollution, based on the assimilative capacity of the receiving environment, is established and allotted in the form of permits to individual polluters. Polluters that keep emission levels below their allotted level may sell their surplus permits to other polluters or use them to offset excess emissions in other parts of their own facilities. Low-cost controllers have an incentive to control to a greater degree than they need and high-cost controllers have the option of buying permits instead of undertaking costly control measures. As with pollution charges, the marginal costs for pollution control tend to be much the same for all polluters and hence the total cost of pollution control to society is minimized.

Deposit-Refund Systems

The classical example of this approach is where the consumer purchasing a potentially polluting product pays a surcharge or deposit. The deposit is refunded upon return of the expended product to an approved centre for recycling or safe disposal. This approach has been extended to include activities such as open cast mining in which case the developer is required to guarantee (by depositing an amount of money or taking out a bond) that sufficient funds are available to implement adequate environmental protection measures.

Water Affairs is presently investigating the whole issue of incentive-based pollution control strategies with the aim of adopting those that would prove appropriate and viable to support its command-and-control strategies.

5.4 Need for policies to reconcile financial and environmental protection goals

Water Affairs is continuously confronted with situations which create conflict between the goal of protecting water quality and the negative financial impacts of its decisions on those whose actions it seeks to control. Some typical situations are outlined.

- An effluent producer has to meet a certain effluent standard in order to ensure that the quality of the receiving water body remains fit for its recognized uses. However, despite the fact that it is technologically feasible to treat the effluent to the required standard, the industry or local authority claims that it cannot afford to do so. When threatened with closure, industries in these situations often cite their role in the regional economy as providers of jobs and as earners of foreign exchange. In many such cases temporary exemptions were granted.

- In two recent cases it was estimated that the capital investment required to treat the effluents to meet the General Standard would amount to R50 million for each case. In both cases disposal of the effluent in its present state did not cause the quality of the receiving water to deteriorate to the point where fitness for recognized uses was reduced. Both industries were granted exemptions from complying with the General Standard on the basis that the required capital investment of R50 million in each case could not be justified by the water quality benefits which would be achieved.

These examples raise many questions.

- When is it justified to sacrifice water quality objectives for economic reasons?

- How is it decided whether or not an industry or local authority can afford to treat its effluent to the required standards?

- On what basis should a decision be taken on whether or not a particular capital investment should be required for the purposes of applying the anticipatory approach to water quality protection?

- It is sound practice to have a system in which the same organization, i.e. Water Affairs, is responsible for considering both the water quality and economic implications of its decisions? Would it not be preferable for Water Affairs to base its decisions purely on water quality considerations and for those who find that for financial reasons they cannot comply, to have the right of appeal to another body?

Water Affairs realises the importance of having policies that are acceptable both to the general public and to industry and is accordingly conducting investigations to that end.

5.5 Need for policies to deal with groundwater pollution

Despite possible differences at strategic and operational levels, groundwater quality management objectives should be in line with surface water quality objectives. Groundwater and surface water resources are highly interrelated. A spring is an obvious example. Rivers recharge groundwater systems and groundwater contributes to the base flow of rivers.

Human activities in a catchment affect both groundwater and surface water, either directly or through the interconnection.

Because of the longevity of impacts and the difficulty of predicting them in groundwater systems, the trend in groundwater management worldwide is towards sustainable resource use. This is clearly in line with the policies pronounced by the South African Council for the Environment.

Groundwater protection policies range from maintaining groundwater quality at its natural background level to levels that may be needed to protect current and anticipated uses. It is generally accepted that not all groundwater resources need to be protected to the same degree. To attempt this would be economically intolerable, hydrogeologically unattainable and unrealistic in terms of management and control.

Criteria on which differentiated protection could be based are -

- the value of groundwater and its vulnerability;
- the volume of rationally utilizable groundwater resources;
- the current and expected water demands within a given region;
- implementation of effective legislation related to groundwater protection and pollution.

Most developed countries have established classification systems, based on a combination of the above criteria, to decide on the level of protection required for a specific aquifer.

To ensure that pollution prevention resources are focused on the most important and most vulnerable aquifers, with less stringent control in other areas, a differentiated protection policy is needed. To address all significant impacts, including mining, urbanisation, waste disposal and intensive agricultural practices, aquifer protection problems has been comparatively small. The main reason is the reduced temporal and spatial bio-availability of the phosphorus load derived from non-point sources.

Non-point source pollution such as stormwater runoff from urban areas, especially informal settlements, is already creating severe water quality problems. Extreme examples are the pollution of False Bay in the Western Cape and the Mgeni River in Natal. Of particular concern are the high levels of bacteria and viruses that pose threats to the health of people using such polluted water bodies for potable or recreational purposes. At present not much is being done to control pollution by urban storm water runoff but Water Affairs is conducting investigations aimed at -

- quantification of the role of non-point sources in water pollution and review of the literature on policies and management strategies used elsewhere in the world;

- clarification of Water Affair's role in relation to those of other government departments and regional and local authorities in facilitating control of non-point source pollution.

Policies for dealing with non-point source pollution will be formulated at the outcome of these investigations.

5.7 Hierarchy of water quality management goals

In any situation where several policies determine management goals, it is important to determine priorities. To ensure consistency in reaching and implementing management decisions, a decision-making hierarchy must be developed incorporating prioritisation of the goals. The decision-making hierarchy must be designed to gain public confidence in the regulatory system and the system must therefore be clear, accessible, easy to understand and simple in operation.

The proposed hierarchy reflects the present Water Affairs policy and embodies aspects of the precautionary principle and is outlined here.

- Source reduction, recycling, detoxifying, neutralizing, etc. of wastes will be encouraged. Because mandatory standards for waste reduction or minimization are not currently feasible, Water Affairs will promote voluntary action.

- If there is no alternative to the discharge of an effluent, then the precautionary principle will be applied, i.e. the effluent must meet minimum standards which may be either uniform or industry-related. The current General and Special Effluent Standards can probably be adapted to serve as minimum standards.

- If the requirement for effluent to meet the minimum effluent standards is insufficient to maintain the fitness for use of the receiving water body, then standards stricter than the minimum effluent standards will be enforced. Such stricter standards will be site-specific and will be based on the results of a waste load allocation investigation according to the Receiving Water Quality Objectives approach.

- Exemptions from compliance with minimum effluent standards will be considered only as a last resort and only if the receiving water body has enough assimilative capacity to absorb the waste without affecting its fitness for use. Relaxations would have to be justified on the basis of technological, economic and socio-political considerations.

Water Affairs appreciates the need to develop clear guidelines on how this decision-making hierarchy should be applied in individual cases. It plans to address this task immediately.

6. CONCLUSIONS

Underlying Principles affecting water quality management policy and strategy development

Cognisance must be taken of the following underlying principles that affect development of water quality management strategies and policies:

- Because South Africa is a water scarce region, re-use of effluent is a vitally important supplement to freshwater resources. Effluent, with accompanying pollutants, must therefore be returned to the natural water bodies for re-use.

- The Water Act, in common with water pollution control legislation in most developed countries of the world, does not require Water Affairs to ensure that the quality of marine and fresh water resources remain in a pristine state except where this can be justified by the requirements of one of the recognised water uses.

- Economic development should not be at the expense of the environment. Strategies and policies should achieve a balance between sustained economic development and environmental protection.

- It is accepted that the water environment normally has a capacity, usually quantifiable, to assimilate non-hazardous pollutants without detriment to predetermined quality objectives. This assimilative capacity is part of the water resource and must be judiciously managed and equitably shared by all water users.

- In terms of water quality management, the Water Act, 1956 (Act 54 of 1956) adequately recognises all relevant water uses.

- The Uniform Effluent Standards approach to pollution control, as applied over the past three decades, has not provided an adequate basis for effective control and management of the quality of the country's water resources.

- Deteriorating water quality, mainly due to changing economical, political, social and demographic circumstances, coupled with increasing concern for environmental and ecological degradation, initiated investigations into a more effective and dynamic approach to water quality management.

- Initial steps have been taken through implementation of the Receiving Water Quality Objectives approach, which focuses on the impact of pollutant loads (wastes) on the receiving water body.

- To counter the limitations of this approach and consistent with environmental policy development worldwide, Water Affairs has decided to embody in its water quality management policy aspects of the anticipatory or precautionary principle to environmental protection. This principle encompasses all types of action to avert danger and minimise risk to the environment.

- The consistent execution of this policy will require a hierarchy of water quality management goals. The hierarchy contains elements of Water Affairs' present policy but embodies the precautionary principle in the form of both source reduction and the application of minimum effluent standards. Until the policy is fully operational, the current General and Special Effluent Standards can provisionally serve as minimum effluent standards. The hierarchy of water quality management goals is as follows:

  - Source reduction, recycling, detoxifying, neutralisation etc. of wastes will be encouraged. Because mandatory standards for waste reduction or minimisation are not currently feasible, Water Affairs will promote voluntary action.

  - If there is no alternative to disposal of an effluent, the effluent must meet minimum standards, which may be either uniform or industry-related. The current General and Special Effluent Standards approach can probably be adapted to serve as minimum standards.

  - If the application of minimum effluent standards is insufficient to maintain the fitness for use of the receiving water body, then standards stricter than the minimum effluent standards will be enforced. Such stricter standards will be site-specific and will be based on the results of a waste load allocation investigation in accordance with the Receiving Water Quality Objectives approach.

  - Exemptions from compliance with the minimum effluent standards will be considered only as a last resort and only if the receiving water body has sufficient assimilative capacity (ability to absorb the waste without affecting its fitness for use). Relaxations would have to be justified on the basis of technological, economical, physical and socio-political considerations.

To ensure consistency in the application of the hierarchy to individual cases, decision-making guidelines have to be developed. These guidelines must be accessible to the general public and must be clear and easy to understand.

Consequences and implications arising from proposed policies and strategies

To ensure the systematic development and consistent application of the proposed policies and strategies, a number of implications and additional requirements have been identified:

- The management of water quality and water supply must remain an integral part of overall water resources management and should therefore remain the responsibility of a single authority.

- Water quality management must be integrated with national environmental management policies and the selection of the best practical environmental options, rather than the best practical water quality options, must be investigated.

- Representatives of recognised water users should be involved in the determination of the desired quality of water resources. There are at present no suitable structures for involving the representatives concerned. Such structures must be established.

- If choosing between different effluent disposal options, Water Affairs will in principle support the best option from an economical, technological, social, political and environmental point of view. This entails evaluation of the various disposal systems with the aid of environmental impact assessments, cost analyses and waste load allocations.

- The polluter pays principle requires dischargers of effluent to meet the cost of treating their effluents and repairing the consequences to the environment of their discharges. Where polluters cannot be held accountable, the cost of environmental rehabilitation has to be borne by the taxpayer.

- A co-operative rather than an adverserial approach should be sought to solve pollution problems. Charges should be laid only as a last resort where the offender is wilfully and/or negligently violating the requirements of the Water Act and is clearly unwilling to take the necessary steps to comply.

- Historically emphasis was placed on the protection of the quality of South Africa's surface and marine water resources. Policies and strategies to deal with groundwater pollution require urgent attention. Establishment of a differentiated protection policy is favoured, based on economical and hydrogeological factors.

- Pollution control efforts so far have been directed mainly to point source pollution. Studies have been initiated to address control of non-point pollution sources, such as contaminated stormwater runoff from informal settlements, urban and mining areas.

- The implementation of these technologically and managerially more demanding policies and strategies requires better qualified and more experienced personnel. The availability of experienced consultants and of sufficient suitably qualified personnel in Water Affairs has to be addressed.

Actions requiring immediate attention for implementation of water quality management and strategies

For continious policy development and the consistent application of water quality mangement strategies and policies, a number of investigations and issues to be addressed as a matter of priority, have been identified:

- Development of policies and procedures for establishing water quality criteria or guidelines for the different user sectors.

- Applications of the Receiving Water Quality Objectives approach in practice revealed the need for detailed procedures ragarding establishing objectives, allocating assimilative capacity, delination of water sources and dealing with changing future water quality requirements.

- Development of decision-making criteria and guidelines for consistent execution of various water quality management policies. This is crucial for the rational application of the hierarchy of water quality management goals.

- Developing minimum or industry related effluent standards. In the interim the current General and Special effluent standards can serve this purpose.

- Developing water quality monitoring systems to assess water quality in rivers, reservoirs, wetlands, estuaries, inshore sea water and groundwater.
- Development of a comprehensive management information system.
- Investigation into incentive-based pollution control strategies to supplement the command-and-control and polluter pays principles.
- Training and development of water quality managers and education of the public.
- Establishing of appropriate communication, negotiation and decision-making forums and procedures.
- The role of non-point sources of pollution has to be quantified. Management strategies for the control of urban storm water in particular informal settlements, urban and mining areas are required.
- Water quality management investigations have to be prioritized due to limited resources.
- Continuous evaluation and where necessary amendment of the Water Act to meet changing policy requirements.

Concluding remark

The challenge to maintain the fitness for use of the country's water resources, will depend on the implementation of an effective and dynamic water quality management policy, sufficiently flexible to meet the demands of an increasingly complex and rapidly changing South Africa. This will require positive attitudes and co-operation amongst all concerned e.g. authorities, researchers, effluent producers, users and the public.

The purpose of this document is, amongst others, to serve as a basis for discussion on water quality management policy development in South Africa. Consistent with stated policy regarding public participation, those interested are invited to comment on the proposed policies and related issues addressed in this report.

ANNEXURE: GENERAL AND SPECIAL EFFLUENT STANDARDS

GOVERNMENT GAZETTE 18 MAY 1984 NO 9225

REGULATION No. 991 18 May 1984

REQUIREMENTS FOR THE PURIFICATION OF WASTE WATER OR EFFLUENT

By virtue of the powers vested in me by section 21(1)(a) of the Water Act, 1956 (Act 54 of 1956) I, Sarel Antoine Strydom Hayward, in my capacity as Minister of Environment Affairs and Fisheries, hereby prescribe the following requirements for the purification of waste water or effluent produced by or resulting from the use of water for industrial purposes.

1. SPECIAL STANDARD:

Quality standards for waste water or effluent arising in the catchment area draining water to any river specified in Schedule I or a tributary thereof at any place between the source thereof and the point mentioned in the Schedule, in so far as such catchment area is situated within the territory of the Republic of South Africa.

1.1 Colour, odour or taste:
The waste water or effluent shall not contain any substance in a concentration capable of producing any colour, odour or taste.

1.2 pH:
Shall be between 5,5 and 7,5.

1.3 Dissolved oxygen:
Shall be at least 75 per cent saturation.

1.4 Typical (faecal) coli:
The waste water or effluent shall contain no typical (faecal) coli per 100 millilitres.

1.5 Temperature:
Shall be a maximum of 25^0C.

1.6 Chemical oxygen demand:
Not to exceed 30 milligrams per litre after applying the chloride correction.

1.7 Oxygen absorbed:
The oxygen absorbed from acid N/80 potassium permanganate in 4 hours at 27^0C shall not exceed 5 milligrams per litre.

1.8 Conductivity:

1.8.1 Not to be increased by more that 15 per cent above that of the intake water.

1.8.2 The conductivity of any water, waste water or effluent seeping or draining from any area referred to in section 21(6) of the aforementioned Water Act shall not exceed 250 milli-Siemens per metre (determined at 25^0C).

1.9 Suspended solids:
Not to exceed 10 milligrams per litre.

1.10 Sodium content:
Not to be increased by more than 50 milligrams per litre above that of the intake water.

1.11 Soap, oil or grease:
None.

1.12 Other constituents:
1.12.1 Constituents:

Constituent	Maximum concentration in milligrams per litre
Residual chlorine (as CP)	Nil
Free and saline ammonia (as N)	1,0
Nitrates (as N)	1,5
Arsenic (as As)	0,1
Boron (as B)	0,5
Total chromium (as Cr)	0,05
Copper (as Cu)	0,02
Phenolic compounds (as phenol)	0,01
Lead (as Pb)	0,1
Soluble ortho phosphate (as P)	1,0
Iron (as Fe)	0,3
Manganese (as Mn)	0,1
Cyanides (as Cn)	0,5
Sulphides (as S)	0,05
Fluoride (as F)	1,0
Zinc (as Zn)	0,3
Cadmium (as Cd)	0,05
Mercury (as Hg)	0,02
Selenium (as Se)	0,05

1.12.2 The waste water or effluent shall contain no other constituents in concentrations which are poisonous or injurious to trout or other fish or other forms of aquatic life.

2. SPECIAL STANDARD FOR PHOSPHATE:

Waste water or effluent arising in the catchment area within which water is drained to any river specified in Schedule II or a tributary thereof at any place between the source thereof and the point mentioned in the schedule, in so far as such catchment area is situated within the territory of the Republic of South Africa shall not contain soluble orthophosphate (as P) in a higher concentration than 1,0 milligram per litre.

3. GENERAL STANDARD:

Quality standards for waste water or effluent arising in any area other than an area in which the SPECIAL STANDARD is applicable, as described in paragraph 1.

3.1 Colour, odour or taste:
The waste water or effluent shall not contain any substance in a concentration capable of producing any colour, odour or taste.

3.2 pH:
Shall be between 5,5 and 9,5.

3.3 Dissolved oxygen:
Shall be at least 75 per cent saturation.

3.4 Typical (faecal) coli:
The waste water or effluent shall not contain any typical (faecal) coli per 100 millilitres.

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3.5 Temperature:
Shall be a maximum of 35^{0}C.

3.6 Chemical oxygen demand:
Not to exceed 75 milligrams per litre after applying the chloride correction.

3.7 Oxygen absorbed:
The oxygen absorbed from acid N/80 potassium permanganate in 4 hours at 27^{0}C shall not exceed 10 milligrams per litre.

3.8 Conductivity:

3.8.1 Not to be increased by more than 75 milli-Siemens per metre (determined at 25^{0}C) above that of the intake water.

3.8.2 The conductivity of any water, waste water or effluent seeping or draining from any area referred to in section 21(6) of the aforementioned Water Act shall not exceed 250 milli-Siemens per metre (determined at 25^{0}C).

3.9 Suspended solids:
Not to exceed 25 milligrams per litre.

3.10 Sodium content:
Not to be increased by more than 90 milligrams per litre above that of the intake water.

3.11 Soap, oil or grease:
Not to exceed 2,5 milligrams per litre.

3.12 Other constituents:

3.12.1 Constituents:

Constituents	Maximum concentration in milligrams per litre
Residual chlorine (as CP)	0,1
Free and saline ammonia (as N)	10,0
Arsenic (as As)	0,5
Boron (as B)	1,0
Hexavalent chromium (as Cr)	0,05
Total chromium (as Cr)	0,5
Copper (as Cu)	1,0
Phenolic compounds (as phenol)	0,1
Lead (as Pb)	0,1
Cyanides (as Cn)	0,5
Sulphides (as S)	1,0
Fluoride (as F)	1,0
Zinc (as Zn)	5,0
Manganese (as Mn)	0,4
Cadmium (as Cd)	0,05
Mercury (as Hg)	0,02
Selenium (as Se)	0,05

3.12.2 The sum of the concentrations of the following metals shall not exceed 1 mg/*l*: Cadmium (as Cd), chromium (as Cr), copper (as Cu), mercury (as Hg) and lead (as Pb).

3.12.3 The waste water or effluent shall contain no other constituents in concentrations which are poisonous or injurious to humans, animals, fish other than trout, or other forms of aquatic life, or which are deleterious to agricultural use.

4. METHODS OF TESTING:

All tests shall be carried out in accordance with methods prescribed by and obtainable from the South African Bureau of Standards, referred to in the Standards Act, No. 30 of 1982, as listed in Schedule III.

NOTE (a)Further information and elucidation may be obtained from the Director-General: Environment Affairs, Private Bag X313, Pretoria, 0001.
(b)Government Notices R. 553 of 5 April 1962, R. 969 of 22 June 1962 and R. 1567 of 1 August 1980 are hereby withdrawn.

SCHEDULE I

CATCHMENT AREAS WITHIN THE TERRITORY OF THE REPUBLIC OF SOUTH AFRICA IN WHICH WASTE WATER OR EFFLUENT MUST BE PURIFIED TO COMPLY WITH THE SPECIAL STANDARD

		Division or district
1.	Hout Bay River to tidal water	Cape
2.	Eerste River to tidal water	Stellenbosch
3.	Lourens River to tidal water	Stellenbosch
4.	Steenbras River to tidal water	Caledon
5.	Berg and Dwars Rivers to their confluence	Stellenbosch
6.	Little Berg River to Vogelvlei weir	Tulbagh
7.	Elands and Sonderend Rivers to their confluence	Caledon
8.	Witte River to confluence with Breede River	Paarl, Wellington, Worcester, Tulbagh
9.	Dwars River to Ceres divisional boundary	Ceres
10.	Olifants River to the Ceres divisional boundary	Ceres
11.	Helsloot and Smalblaar (or Molenaars) Rivers to their confluence with Breede River	Paarl and Worcester
12.	Hex River to its confluence with Breede River	Ceres and Worcester
13.	Van Stadens River to tidal water	Port Elizabeth
14.	Buffalo River from the Ciskei border to where it enters the King William's Town municipal area	King William's Town
15.	Swart Kei and Klipplaat Rivers to their confluence	Tarka, Queenstown and Cathcart
16.	Bongola River to Bongola Dam	Queenstown
17.	Kubusie River to the Stutterheim municipal boundary	Stutterheim
18.	Langkloof and Kraai Rivers to their confluence	Barkly East
19.	Little Tsomo River to the Transkei border	St Marks
20.	Xuka River to the Elliot district boundary	Elliot
21.	Tsitsa and Inxu Rivers to their confluence	Maclear, Mount Fletcher, Tsolo and Qumbu
22.	Mvenyane and Umzimvubu Rivers to the Transkei border	Matatiele, Mount Currie and Mount Ayliff
23.	Umzimhlara River to the Transkei border	Mount Currie
24.	Ingwangwana River to its confluence with Umzimkulu River	Umzimkulu, Mount Currie, Polela and Underberg
25.	Umzimkulu and Polela Rivers to their confluence	Underberg and Polela
26.	Elands River to the Pietermaritzburg-Bulwer main road	Impendle
27.	Umtamvuma and Weza Rivers to their confluence	Bizana and Alfred
28.	Umkomaas and Isinga Rivers to their confluence	Impendle, Polela and Underberg
29.	Lurane River to its confluence with the Umkomaas River	Polela
30.	Sitnundjwana Spruit to its confluence with the Umkomaas River	Impendle
31.	Inudwini River to the Polela district boundary	Polela
32.	Inkonza River to the bridge on the Donnybrook-Creighton road	Polela and Ixopo
33.	Umlaas to the bridge on District Road 334 on the farm Maybole	Richmond

		Division or district
35.	Mooi River to the road bridge at Rosetta	Estcourt and Lions River
36.	Little Mooi and Hlatikula Rivers to their confluence	Estcourt
37.	Bushmans River to Wagendrift Dam	Estcourt
38.	Little Tugela River and Sterkspruit to their confluence	Estcourt
39.	M'Lambonjwa and Mhlawazeni Rivers to their confluence	Bergville
40.	Mnweni and Sandhlwana Rivers to their confluence	Bergville
41.	Tugela River to its confluence with the Kombe Spruit	Bergville
42.	Inyamvubu (or Mnyamvubu) River to Craigie Burn Dam	Umvoti
43.	Umvoti River to the bridge on the Seven Oaks-Rietvlei road	Umvoti
44.	Yarrow River to its confluence with the Karkloof River	Lions River
45.	Incandu and Ncibidwane rivers to their confluence	Newcastle
46.	Ingogo River to its confluence with the Harte River	Newcastle
47.	Pivaan River to its confluence with Soetmelkspruit	Utrecht
48.	Slang River and the Wakkerstroom to their confluence	Utrecht and Wakkerstroom
49.	Elands and Swartkops Rivers to their confluence	Belfast and Carolina
50.	All tributaries of the Komati River between Nooitgedacht Dam and its confluence with and including Zevenfontein Spruit	Belfast and Carolina
51.	Seekoeispruit to its confluence with Buffelspruit	Carolina
52.	Crocodile River and Buffelskloofspruit to their confluence	Belfast and Lydenburg
53.	All tributaries of the Steelpoort River down to its confluence with and including the Dwars River	Lydenburg, Belfast, Middelburg, Groblersdal
54.	Potspruit to its confluence with the Waterval River	Lydenburg
55.	Dorps River (or Spekboom River) to its confluence with the Marambanspruit	Lydenburg
56.	Ohrigstad River to the Ohrigstad Dam	Lydenburg
57.	Klein-Spekboom River to its confluence with the Spekboom River	Lydenburg
58.	Blyde River to the Pilgrim's Rest municipal boundary	Pilgrim's Rest
59.	Sabie River to the Sabie municipal boundary	Pilgrim's Rest
60.	Nels River to the Pilgrim's Rest district boundary	Pilgrim's Rest
61.	Houtbosloop River to the Lydenburg district boundary	Lydenburg, and Pilgrim's Rest
62.	Blinkwaterspruit to Longmere Dam	Nelspruit
63.	All streams flowing into Ebenezer Dam on the Great Letaba River	Pietersburg and Letaba
64.	Dokolewa River to its confluence with the Politzi River	Pietersburg and Letaba
65.	Ramadiepa River to the Merensky Dam on the farm Westfalia 223, Letaba	Letaba
66.	Pienaars River and tributaries up to Bophuthatswana boundary	Pretoria, Cullinan and Warmbad

SCHEDULE II

CATCHMENT AREAS WITHIN THE TERRITORY OF THE REPUBLIC OF SOUTH AFRICA IN WHICH WASTE WATER OR EFFLUENT MUST BE PURIFIED TO CONTAIN NO SOLUBLE ORTHO PHOSPHATE (AS P) IN A HIGHER CONCENTRATION THAN 1,0 MILLIGRAM PER LITRE

(i) Vaal River upstream and inclusive of the Bloemhof Dam;
(ii) Pienaars and Crocodile Rivers upstream of their confluence;
(iii) Great Olifants River upstream and inclusive of the Loskop Dam;
(iv) Umgeni River upstream of the influence of tidal water;
(v) Umlaas River upstream of its point of discharge into the sea;
(vi) Buffels River upstream and inclusive of the Bridle Drift Dam;
(vii) Berg River upstream of the influence of tidal water.

SCHEDULE III

EFFLUENT ANALYSIS: SABS STANDARD TEST METHODS

	Reference number of SABS
Ammonia - free and saline	217
Arsenic	200
Bacteriological - faecal coliform, etc.	221
Boron	1 053
Cadmium	201
Calcium hardness	216
Chemical oxygen demand	1 048
Chloride	202
Chlorine - residual	1 052
Chromium - total	1 054
Chromium VI	206
Colour	198
Conductivity	1 057
Copper	203
Cyanide	20
Fluoride	205
Hardness - total	215
Iron	207
Lead	208
Magnesium	1 071
Manganese	209
Mercury	1 059
Nitrate plus nitrite	210
Nitrite	219
Oil and grease	1 051
Oxygen absorbed	220
Oxygen demand (chemical)	1 048
Oxygen dissolved	1 047
pH	11
Phenolic compound	211
Phosphate - ortho	1 055
Selenium	1 058
Sodium	1 050
Solids - suspended	1 049
Sulphate	212
Sulphide	1 056
Turbidity	197
Zinc	214