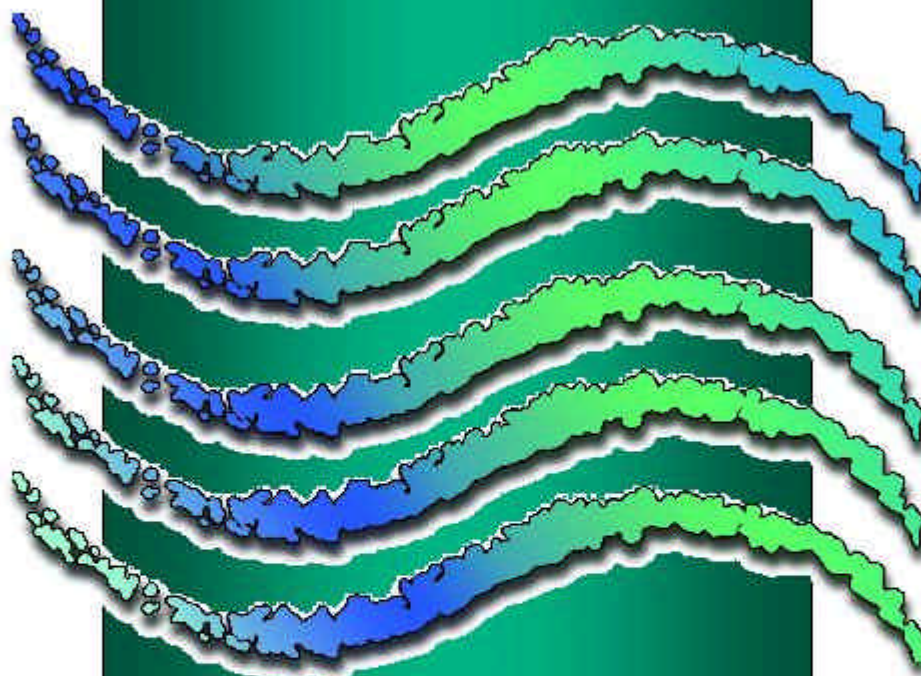


SOUTH AFRICAN
WATER QUALITY
GUIDELINES
FOR COASTAL MARINE WATERS

VOLUME 3

INDUSTRIAL
USE



Department of Water Affairs and Forestry



First Edition 1995

**South African
Water Quality
Guidelines
for
Coastal Marine
Waters
Volume 3
Industrial Use**

**Department of Water Affairs
and Forestry
First Edition
1995**

Published by
Department of Water Affairs and Forestry
Private Bag X313
PRETORIA
0001

Republic of South Africa
Tel: (012) 299-9111

Printed and bound by
The Government Printer, Pretoria

ISBN 0-621-17466-1

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This report should be cited as:

Department of Water Affairs and Forestry. 1995. South African Water Quality
Guidelines for Coastal Marine Waters. Volume 3: Industrial Use.

Coordinated by:

**Earth, Marine and Atmospheric Science
and Technology
CSIR
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STELLENBOSCH
7599
Republic of South Africa**



Foreword

The Department of Water Affairs and Forestry is the custodian of South Africa's water resources. Part of its mission is to ensure that the quality of water resources remains fit for recognised water uses and that the viability of aquatic ecosystems are maintained and protected. These goals are achieved through complex water quality management systems which involve role players from several tiers of government, from the private sector and from civil society.

A common basis from which to derive water quality objectives is an essential requirement that enables all role players involved in such a complex system to act in harmony in order to achieve the overarching goal of maintaining the fitness of water for specific uses and to protect the health of aquatic ecosystems. For these reasons the Department initiated the development of the *South African Water Quality Guidelines*, of which this is the second edition. The *South African Water Quality Guidelines* serve as the primary source of information for determining the water quality requirements of different water uses and for the protection and maintenance of the health of aquatic ecosystems.

The process that followed and the wide variety of organizations and individuals involved in the development of these guidelines ensured the acceptance and use of these guidelines by all significant role players, as the *South African Water Quality Guidelines*. These guidelines are technical documents aimed at users with a basic level of expertise concerning water quality management. However, the role players involved in the different water use sectors are expected to use these guidelines as a basis for developing material to inform water users in specific sectors about water quality and to empower them to effectively participate in processes aimed at determining and meeting their water quality requirements.

The Department recognises that water quality guidelines are not static and will therefore update and modify the guidelines on a regular basis, as determined by ongoing research and review of local and international information on the effects of water quality on water uses and aquatic ecosystems. The process of developing water quality guidelines, and the involvement of key role players, is a continuing one. The second edition is published in a loose leaf, ring binder format to facilitate the regular updating of the guidelines. All those who want to comment on and make suggestions concerning the *South African Water Quality Guidelines* are invited to do so at any time by contacting the Director: Water Quality Management, Department of Water Affairs and Forestry, Private Bag X313, Pretoria 0001.

Finally I wish to express my sincere appreciation to all those who have been involved in the development of these guidelines. I also look forward to their continued involvement in maintaining one of the corner-stones of the water quality management system in South Africa.



Professor Kader Asmal MP
Minister Of Water Affairs and Forestry

May 1996

ACKNOWLEDGEMENTS

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Scaling and scrubbing	Mr C B Newmarch (Alusaf)

ACKNOWLEDGEMENTS continued on next page

ACKNOWLEDGEMENTS continued...

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Workshop participants for setting target values The target values or guideline values for the South African coastal zone were reviewed at a workshop held in 1992 in Stellenbosch. The workshop consisted of a broad spectrum of representatives from the scientific and engineering community, national and local authorities, industries and environmental organisations. The list of participants is presented below:

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Mr A B Davis, Durban Corporation	Mr J L Pretorius, DWAF, Eastern Cape
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Mr L Gravelet-Blondin, DWAF, Natal	Mr J L J van der Westhuizen, DWAF, Pretoria
Dr L Jackson, SFRI, Cape Town	Mr O A van der Westhuizen, Foundation for Research Development
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INTRODUCTION TO THE SOUTH AFRICAN WATER QUALITY GUIDELINE DOCUMENTS

The South African Water Quality Guidelines are a series of nine documents published by the Department of Water Affairs and Forestry (DWAF). They form an integral part of the water quality management strategy to maintain South Africa's water resources fit for use. The guideline documents are presently divided into two sets:

Water Quality Guidelines for Fresh Water

- Volume 1: Domestic Water Use
- Volume 2: Recreational Water Use
- Volume 3: Industrial Use
- Volume 4: Agricultural Use: Irrigation
- Volume 5: Agricultural Use: Livestock Watering
- Volume 6: Agricultural Use: Aquaculture
- Volume 5: Aquatic Ecosystems
- Volume 8: Field Guide

Water Quality Guidelines for Coastal Marine Waters

- Volume 1: The Natural Environment
- Volume 2: Recreational Use
- Volume 3: *Industrial Use***
- Volume 4: Mariculture (the effects and target values related to *human health* also apply to the *collection of seafood* along the coast)

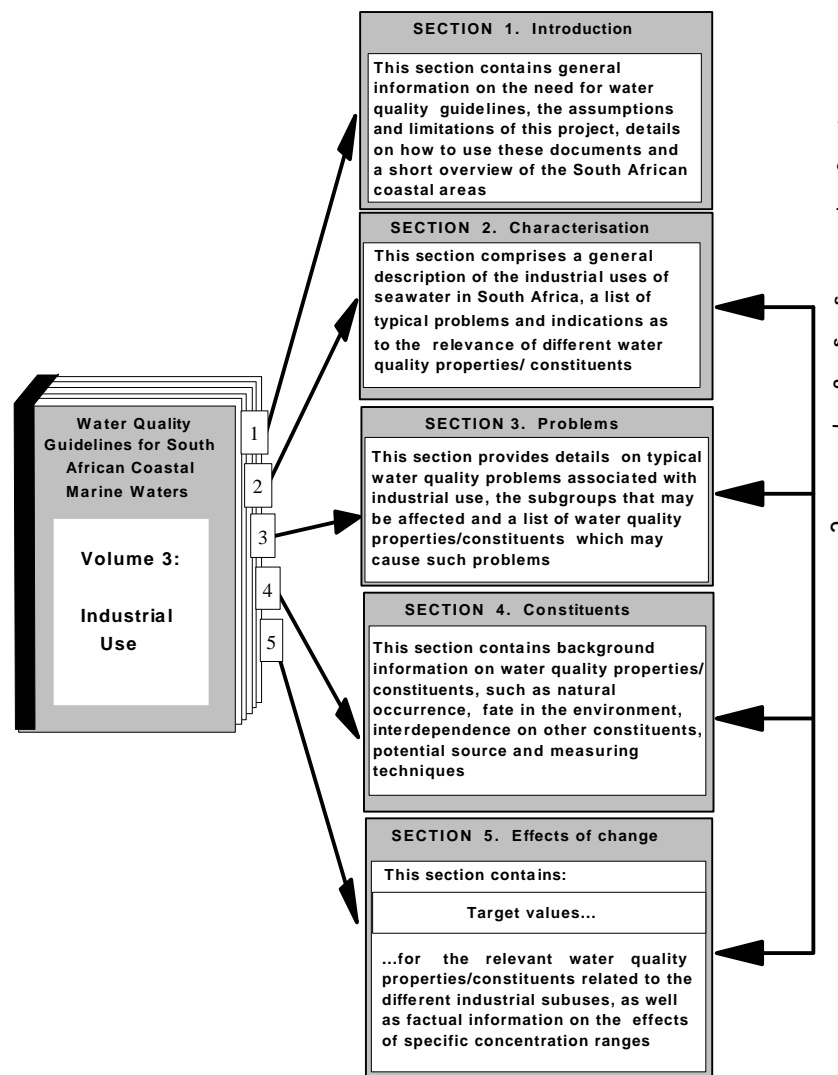
This volume is the third in a series of four documents comprising the first edition (Edition 1.0) of the South African Water Quality Guidelines for Coastal Marine Waters.

NOTES: Should seawater be used for domestic purposes the guidelines (and target values) will be similar to those described in the set of documents for fresh water, Volume 1, i.e. Domestic Use of fresh water. Desalination of seawater is dealt with in the set of documents for coastal marine waters, Volume 2, i.e. Industrial Use of coastal marine waters.

These documents do not specifically address estuaries or river mouths, although some of the information contained therein may be applicable. However, the need for expansion of the series to include estuaries will receive attention in the future.

HOW TO USE THIS DOCUMENT

The terms of reference for this project specified that the information contained in these documents had to address the needs of all parties involved in marine water quality, from the analyst to the manager. With the diversity of the user spectrum and the complexity of information in mind, the layout of the documents was designed in such a way so as to allow the user to 'enter' via a number of perspectives or subjects. This was accomplished by dividing the documents into different sections:

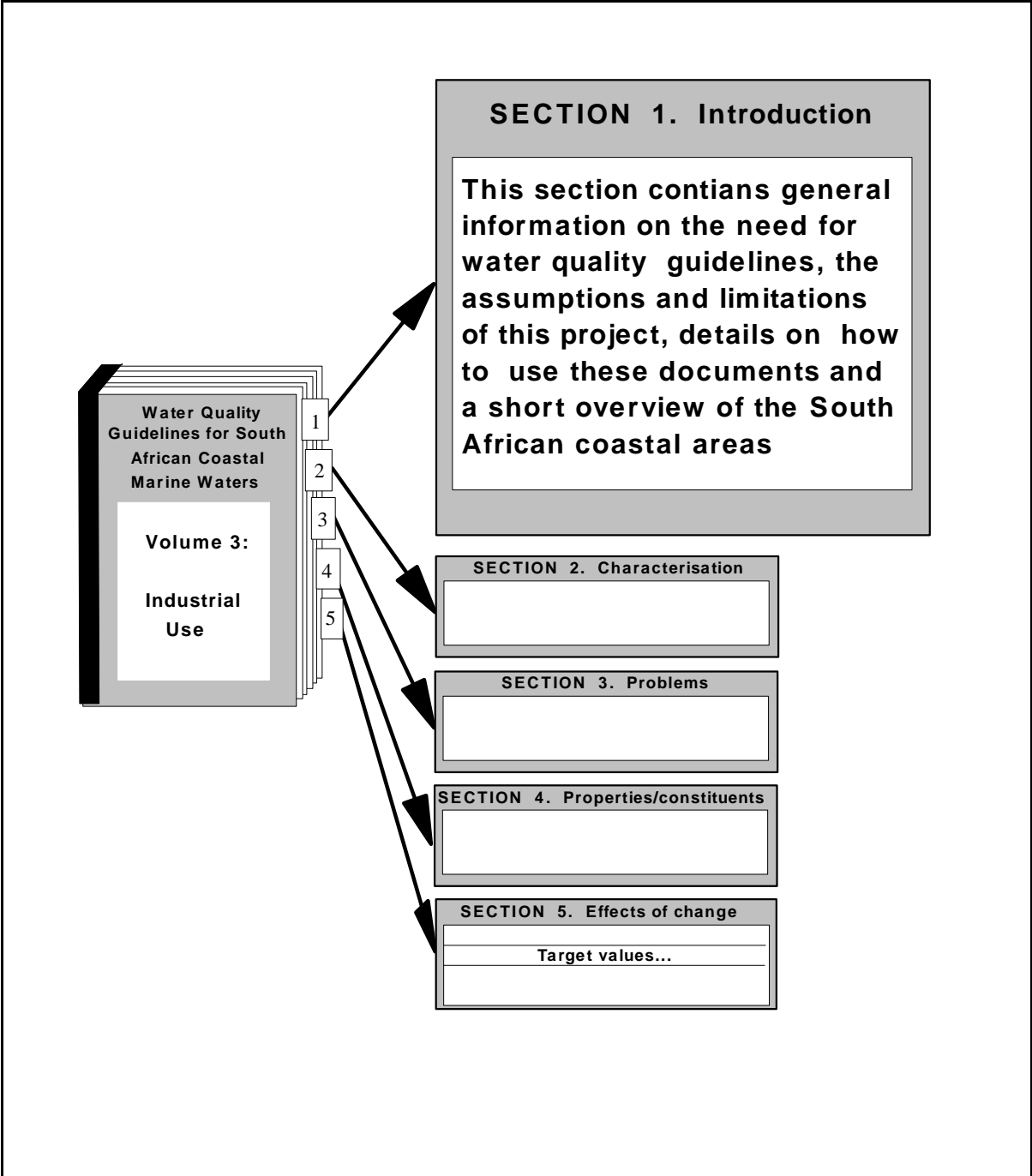


A certain degree of overlap and/or repetition was inevitable. However, to avoid unnecessary repetition of detailed information, a cross-reference system has been used. *Section 5 is regarded as the 'heart' of these documents (containing the target values), with the information contained in Sections 2-3 being complementary to that section.*

PRACTICAL EXAMPLES OF HOW TO USE THIS DOCUMENT

Issue	Reference method
A development, with potential influence on water quality is planned in an area where fish factories are abstracting seawater for industrial purposes	The subject is <i>'the user-group, i.e. seawater used for seafood processing'</i> , therefore refer to <i>Section 2: Characterisation of industrial uses</i> . Find an overview of the use of seawater for seafood processing, a list of typical problems and a checklist of the relevance/non-relevance of water quality properties/constituents. Cross-references to Section 4 provide more details on, for example, the potential sources of the relevant properties/constituents, which in turn, could be matched to potential sources associated with the development. Where available, cross-references to Section 5 provide factual details on effects of different concentration ranges of relevant constituents/properties on marine organisms. Where available, the target values for South African coastal marine waters are also provided.
A water quality manager is told by a factory that its inlet pipes for seawater are clogging	The subject is <i>'a problem'</i> , therefore refer to <i>Section 3: Water quality problems</i> . Select the problem which addresses the issue, i.e. clogging and blockage of equipment. Find a short description of the problem, the subgroups which could be affected and a list of relevant water quality properties/constituents which could cause such a problem. Cross-references to Section 4 will provide further details on the properties/constituents, for example, potential sources. Where available, cross-references to Section 5 will provide factual details on effects of different concentration ranges of the relevant constituents/properties.
A water quality analyst finds exceptionally high nutrient levels in a water sample	The subject is <i>'a particular water quality constituent'</i> , therefore refer to <i>Section 4: Water quality properties/constituents</i> . Select the constituent, i.e. <i>Nutrients</i> . Find a short description of the constituent, including useful background information on its natural occurrence, its fate in the environment and potential anthropogenic sources. Cross-references to Section 3 provide details on typical water quality problems associated with the constituent. Where available, cross-references to Section 5 will provide factual details on effects of different concentration ranges of a constituent, as well as the target values for South African coastal marine waters.

SECTION 1: INTRODUCTION



SECTION 1: INTRODUCTION CONTENTS

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THE NEED FOR WATER QUALITY GUIDELINES

Receiving water quality objectives approach

In South Africa, the ultimate goal in water quality management is to keep the water resources suitable for all designated uses. To achieve this goal, the Receiving Water Quality Objectives (RWQO) approach has been adopted. This implied that water quality objectives, set for a particular marine environment subjected to potential impact from a development, must be based on water quality requirements of designated uses in that particular area. Both point and diffuse waste loads must be taken into account, while it is also recognised that the marine environment has a certain capacity to assimilate waste without detrimental effect.

Different requirements

The water quality requirements of the different user groups are not necessarily the same. In some instances, they may even conflict. These differences imply that water which would be adequately fit for use for one specific user may not be suitable for another. In addition, water seldom becomes totally unfit for use when the quality deteriorates. Quality is thus not an intrinsic property of water, but is linked to the use made of the water. A definition of what constitutes fitness for use is thus a key issue in the evaluation and management of the quality of water resources.

Decision-making tool

The need arose for a set of documents that would contain the relevant information to assist decision-makers in defining water quality objectives or water quality requirements for the different uses.

The information captured in these documents is therefore aimed at giving a general overview of the different components which are important in marine water quality management, such as:

- the different uses and the associated water quality problems;
- information on the relevant water quality properties and constituents;
- effects of change in water quality (including target values, where available) on different uses or users.

Most of the abovementioned information has been published, but in many different books, journals and manuals.

THE NEED FOR WATER QUALITY GUIDELINES continued on next page



THE NEED FOR WATER QUALITY GUIDELINES continued...

**Different
uses**

Water quality managers and scientists would use these documents to:

- serve as a scientific basis for the quantification of the water quality requirements for a water use;
- interpret and translate information obtained from water-quality monitoring and assessment programmes;
- assess the effect of anthropogenic activities on water quality;
- evaluate the impact of accidental spills;
- assess and evaluate management performance, effective control and auditing of water quality management practices which are essential and fundamental to good management;
- deal with public perceptions; in South Africa, as in the rest of the world, there is a growing awareness among the public of the natural environment and how it is being managed; decision-makers and water quality managers need sound scientific norms and guidelines to enable them to communicate effectively with the public on the impact of development on water quality and to deal with public perception, fears and complaints with regard to water pollution and its effects on water users;
- identify research needs (i.e. indicate where information is lacking).

These documents also provide the necessary information for water users and other interested and affected parties to assess water quality in general, as well as to evaluate the acceptability of the impact of development on water quality.

THE NEED FOR WATER QUALITY GUIDELINES continued on next page



THE NEED FOR WATER QUALITY GUIDELINES *continued...*

Target values

In principle, the water quality objectives or requirements of a particular water body are the *target values of the different water quality properties/constituents which have been set for the designated beneficial uses.*

The target values, i.e. 'level of a particular water quality property/constituent at which no detrimental impact should occur', described in Section 5, were taken from *Interim report: Water quality guidelines for the South African coastal zone.* Those target values were decided upon by a group of marine water quality experts in 1992⁽¹⁾.

Practical application

At the workshop held in Stellenbosch in 1992, it was decided, in principle, that the target values set for the beneficial uses, *Recreation: Non-contact*, i.e. ensuring basic amenities (see Volume 2) and the *Natural Environment* (see Volume 1), should apply to **all** marine waters. Additional to these will be *Recreation: Primary contact and secondary contact, Mariculture and Industrial uses*, where these are designated beneficial uses of a particular water body.

In principle, a *zone of impact*, i.e. an area or volume of seawater where water quality does not comply with the target values, could be considered acceptable in the case of a marine discharge. This zone of impact should, however, be kept at a minimum and should be determined through an appropriate environmental impact assessment.



ASSUMPTIONS AND LIMITATIONS

Scope

The scope for this phase of the project was to provide additional information to enhance the existing water quality guidelines for the South African coastal zone ⁽¹⁾, similar to those documents produced for the fresh water environment of South Africa ⁽²⁻⁵⁾.

The information provided in these document had to be focused on the coastal marine environment, the outer boundary roughly going up to the edge of the continental shelf, but excluding estuaries. However, the need for expansion of the series to include estuaries will receive attention in the future. Some information provided in the present documents may, however, be applicable to estuaries.

It should be noted that although these documents focus on the area inshore of the continental shelf, South African marine waters extend up to 200 km offshore. Beyond the 200 km boundary, international conventions and agreements apply to all users of the ocean.

Time and budget

The present set of documents for the coastal marine environment had to be compiled within a period of one year and within a limited budget. Within these time and budget limits, it was therefore decided that the present set of documents, i.e. Edition 1.0, had to provide a **basic framework within which existing information could be consolidated and which would also allow for future updates**, as information and funding became available. To assist in directing future updates, it therefore had to indicate the relevance/non-relevance of different aspects, as well as highlight aspects where information was lacking.

Information sources

Taking into account the time and cost constraints, it was decided to select the internationally recognised databases best suited to obtaining information on water quality issues. The databases which were decided on were:

ASFA (1983 to 1993) which includes topics such as:

- biological resources and living resources;
- ocean technology, policy and non-living resources;
- aquatic pollution and environmental quality;
- aquaculture;
- marine biotechnology.

WATERLIT (1975 to 1994), a CSIR database which contains information on water-related issues.

ASSUMPTIONS AND LIMITATIONS continued on next page



ASSUMPTIONS AND LIMITATIONS *continued...*

Information sources
continued...

Relevant keyword selections, as provided by the different specialist groups, were used to extract information from the databases.

Appropriate databases on a *national* scale were found to be limited, or in some instances, non-existent. Where possible, the different universities and institutes involved in water quality studies were contacted individually. It was however assumed that specialists would be aware of important studies which have been conducted nationally in their field of expertise.

With particular reference to Section 5 (Effects of Change in Water Quality), South African (local) information was generally limited. For this reason, it was decided to include any international data which may assist in showing trends in effects at different concentration ranges in the different trophic levels, although these may not be of the exact species as found in South Africa. As more local information becomes available, international data can be excluded from later editions.

However, these documents are NOT detailed specialist publications on the physics, chemistry or biology of the marine environment. The aim was to include information from these expert fields which are considered to be relevant to marine water quality management. The reference lists can be used to obtain more detailed information.



OVERVIEW OF THE SOUTH AFRICAN COASTAL AREAS

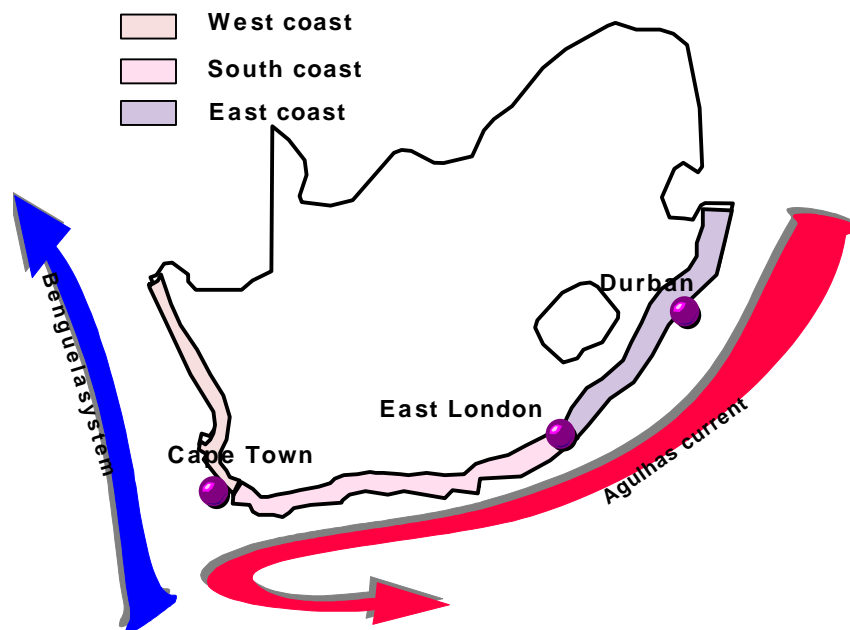
Uniqueness of seawater

Although the quality of seawater differs from fresh water in many ways, its high dissolved salt content is probably the most distinctive characteristic. This is discussed in more detail in *Section 4, Salinity, p 4-1*.

Coastal regions

The South African coastal water can typically be divided into three coastal regions, each of which sustains distinctive characteristics :

- ! West coast: cold temperate
- ! South coast: warm temperate
- ! East coast: subtropical/tropical.



OVERVIEW OF SA COAST continued on next page



OVERVIEW OF SA COAST continued...

Coastal regions
continued...

West coast. The west coast of South Africa is defined as that section of coast extending from Cape Agulhas in the south-east to the Orange River in the north-west. The cold Benguela system has a great influence on the physical and biotic characteristics of the west coast. The western coast of South Africa is dominated by coastal upwelling. This upwelling is driven by south-easterly and southerly winds which, in combination with Coriolis forces, leads to offshore drift of surface waters. Biological communities along the west coast generally exhibit low species richness, with high biomass values being achieved by a few species, including kelps, limpets, black mussels, white mussels, abalone, rock lobsters and a number of fish and bird species. The most important industry along the west coast is the fish-processing plants. The west coast is also a popular tourist area.

South coast. The south coast of South Africa is defined as that section of coast extending from Cape Agulhas to East London. The south coast is considered to be a transition zone between the cold temperate and warm subtropical regions. The Agulhas bank area is a large mixing area between the cold Benguela and warm Agulhas currents. The overlapping of different current systems along the south coast is reflected in the biota which is characterised by high species diversity. Although high in species diversity, not many species occur in such magnitude to sustain high rates of exploitation. Fishing consists mainly of lobster, demersal fish (e.g. hake and sole), pelagic fish and chokka squid, the latter being the only chokka squid line fishery in South African waters.

East coast. The east coast of South Africa is defined as that section of coast extending from north of East London up to the Mozambique border. This region can typically be further subdivided into a tropical (north of Port Edward) and subtropical coast. The warm Agulhas current is the greatest factor influencing the coastal marine environment along the east coast of South Africa. Generally, the east coast fauna and flora are relatively low in total biomass but species diversity is high with distinct Indo-Pacific affinities. Numerous industries e.g. paper and pulp, textile and chemical industries are situated along the southern part of the east coast. The east coast is also a very popular tourist attraction.

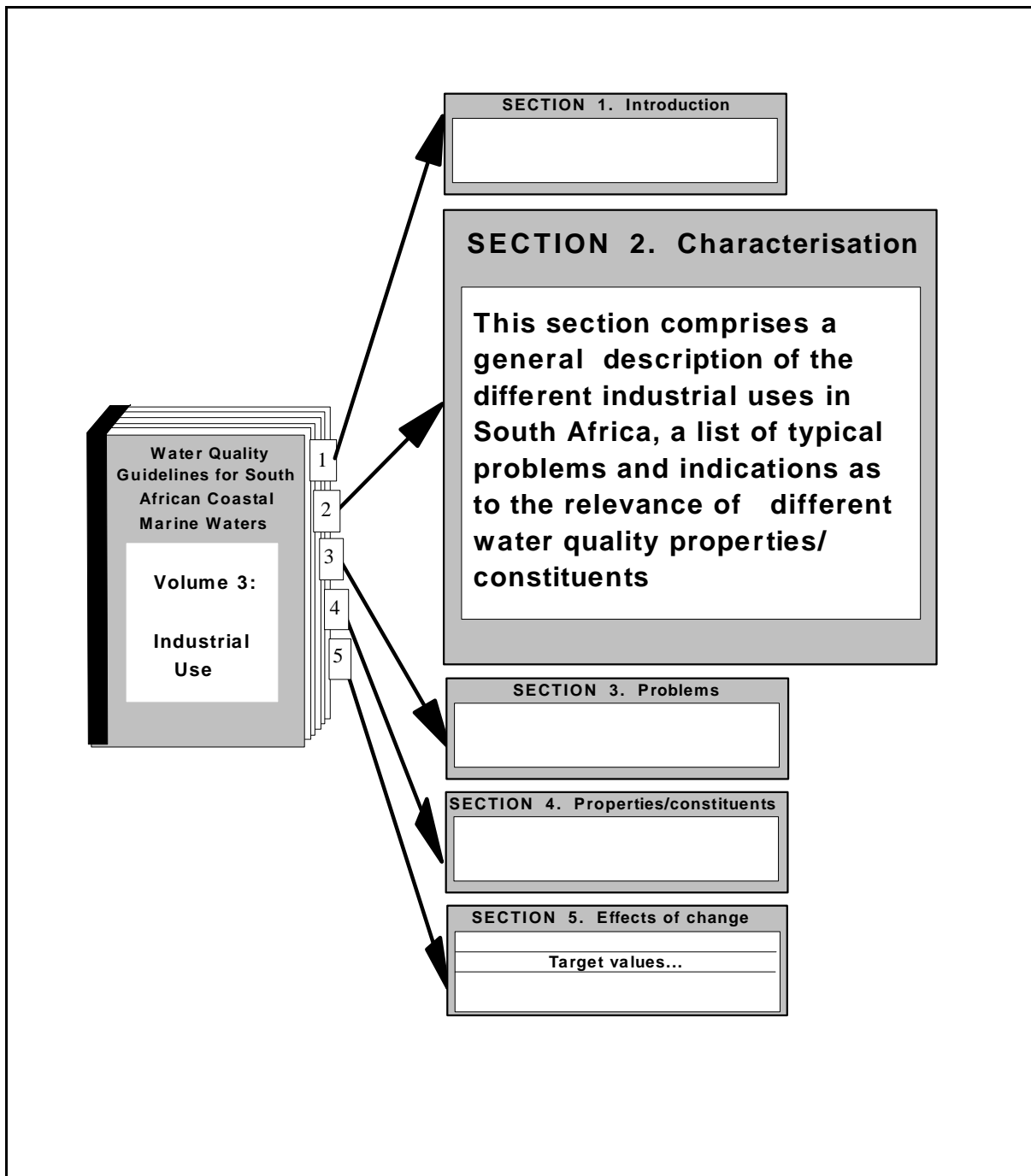
Detailed descriptions of the characteristics of the coastal regions, both abiotic and biotic features, are provided in *Volume 1: Natural Environment, Section 2.*



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 3. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1993. South African Water Quality Guidelines. Volume 2: Recreational Use.
 4. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1993. South African Water Quality Guidelines. Volume 3: Industrial Use.
 5. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1993. South African Water Quality Guidelines. Volume 4: Agricultural Use.
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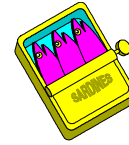
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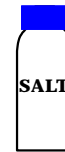
GENERAL INTRODUCTION

In South Africa seawater is used in a number of industrial related activities. These include:

Seafood Processing



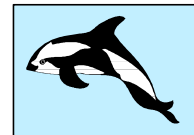
Salt Production



Desalination



Aquariums and Oceanariums



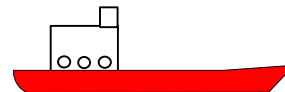
Harbours and Ports



Cooling Water



Ballast Water



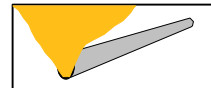
Coastal Mining



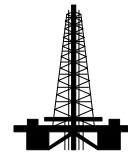
GENERAL INTRODUCTION continued on next page

GENERAL INTRODUCTION continued...

Make-up Water for Marine Outfalls



Exploration Drilling



Scaling and Scrubbing



NOTE: This document will mainly focus on water quality matters related to *industrial processes* i.e. where water quality may interfere with the mechanical operations or with the industrial processes.

In the industrial uses of seawater, additional factors may also be of importance, e.g. *human health* aspects where the products will be used for human consumption, or *biological health*, where marine organisms are included in the process. Because the latter aspects are dealt with in detail in other volumes of this series, will only be highlighted in this volume with cross-references to the applicable volumes.



Chapter 2.1 Seafood Processing

DESCRIPTION OF USE

Uses Generally, five categories can be distinguished in the fish-processing factories: Abalone processing, crayfish processing, white fish processing, canning and fishmeal production. Seawater is used in a variety of ways in each of these processes. Most fish-processing factories are located on the west and south-west coasts.

Abalone Processing. Abalone (perlemoen) is delivered to the plant by contract divers, the meat is then taken out of the shells and the inedible parts are removed, after which the meat is washed in seawater. The meat is then salted dry and frozen. The frozen meat is placed into cans which are topped up with fresh water. These cans are sealed, cooked and packed.

Crayfish Processing. Crayfish are delivered to the processing plants in baskets. They are washed with seawater and flumed (transported) to the cutting tables, the washwater being used as the transport medium. The tails are separated from the main body, washed again and flumed to the degutting tables. There, the alimentary canal is removed and the tails are then subjected to a final washing after which they are graded into different sizes before being packed into boxes for freezing at a temperature of -35EC. Before processing, the crayfish are often held for a longer or shorter period in holding tanks filled with seawater.

White Fish Processing. Fish is offloaded at the plant in plastic baskets and transported to a flume where they are inspected to ensure that the cleaning at sea has been properly completed. From the flume the fish is then sorted and transferred to the filleting area. Small hake and small species of fish such as mackerel, maasbanker and gunard are cleaned and packed as whole fish. Larger fish are filleted either by machine or by hand. After filleting, hake, John Dory and angel fish fillets are passed through a skinning machine for skin removal. All broken pieces of fish are sent off to a deboner and to mincing machines for mince-making.

Fish fillets are transferred to the packing area for fish finger manufacture or as fillets in commercial packs.

Mince and broken fish are cut into fish fingers or used in pet food blocks. After freezing, all fish products are transferred to a processing table for final processing and packing.

Both seawater and fresh water are used for washing and cleaning fish, as flume water and for cleaning the plant (equipment and floors).

DESCRIPTION continued on next page



DESCRIPTION continued ...

Uses
continued...

Canning Plants. The processing plants in South Africa generally make use of pilchards for canning purposes. Most cans are for the domestic market while some are exported. The fish are generally offloaded from the fishing vessels by a wet offloading process as this results in a minimum fish damage. Seawater is added to fluidise the catch in the boat hold, and then pumped out and flumed in the offloading water to the process plant. The fish are then dewatered, weighed and stored in holding pits. As required, the fish are flumed to cutting tables for the removal of the heads, tails and guts. The prepared fish are then packed into cans which are precooked. All liquid is drained out of the cans and a variety of sauces or brines are added. The cans are then sealed and cooked before being cooled, packed and stored. About 40% by weight consists of waste material which is used in the fishmeal plant. Seawater is used for offloading, fluming, cleaning of the fish and for plant and floor washing.

Fishmeal Production. Fishmeal production involves the production of a dry milled fish product used mainly as chicken feed. All fishmeal is locally consumed (South Africa actually imports fishmeal). In South Africa, offloading from the vessels is generally by means of a dry offloading technique whereby the fish are sucked up by means of vacuum pumps. A small amount of seawater is generally added to assist with 'liquidising' the catch. Anchovy is generally used for fishmeal production, to which the offal from the canning and white fish processes is added. After offloading, the fish pass over a dewatering reel and are weighed and cooked. The mixture is then pressed to expel the oily fractions. The oily liquid is centrifuged to separate the solids and is subsequently polished (purified) by the addition of heated fresh water, followed by further centrifugation. The solids and some of the effluent streams are sent to evaporators and the dry matter added to the press cake. The largest quantity of seawater is used as cooling water for these evaporators. The dry product is then milled and bagged. Seawater is further used for plant and floor washings.

Seawater Usage in Fish-processing Factories. In summary, seawater is used for offloading the catch and for transporting (fluming) the fish to the factory and within the factory itself. It is also used for washing and cleaning fish, abalone and crayfish. Finally, it is also used as cooling water for fishmeal production and for the washdown of the plant, equipment and floors. The storage of crayfish in seawater holding tanks is generally not regarded as an industrial use. A rough estimate of the amount of seawater involved is in the order of about four million cubic metres per year.

The seawater is generally abstracted by means of a pipeline along a jetty used by the fishing vessels. Sometimes separate inlet systems (somewhat removed from the offloading areas and not affected by effluent discharges) are used to ensure a higher quality intake water.

DESCRIPTION continued on next page



DESCRIPTION continued ...

Uses Primary treatment generally consists of bar or wire screens to remove larger particles. No further treatment is carried out on seawater used for offloading and fluming the catch to the factory as the contact times are short and the fish are still whole. Seawater used as cooling water during fishmeal production does not come into contact with the fish products and is therefore not treated further. The quality of the seawater used for processing, washing and cleaning as well as for plant washdown and cleaning equipment and floors is very critical as any water quality problems can be easily passed on to the final fish products. This water is generally treated by filtration and flocculation, followed by chlorination and/or UV radiation. Some of the smaller plants processing lobster generally rely solely on UV radiation, while the abalone processing plants do not carry out any additional treatment; the reason being that the intake water of both lobster and abalone plants is generally of a better quality.

Problems	Problems associated with the use of seawater in seafood processing include:	For more details on problems refer to:
	i. corrosion;	p 3-1
	ii. clogging of the pipes and pumps;	p 3-2
	iii. human health problems, where seawater is used for processing of products for human consumption;	Problems iii. to v. are not addressed in further detail in this document. Details on these can be obtained from Volume 1: <i>Domestic Use</i> in the set of fresh water documents and Volumes 1 and 4: <i>Natural Environment</i> and <i>Mariculture</i> in the set of coastal marine documents
	iv. tainting problems, where seawater is used for processing of products for human consumption;	
	v. biological health, where marine organisms are processed.	

Presently, the processing factories in South Africa are generally located on relatively unpopulated stretches of coastline and the abstracted quality of the seawater is generally good and is to a large extent only affected by the fish offloading activities from the vessels and by the effluent discharged from the processing factories themselves. The present problems related to the water quality of the intake water are therefore relatively minor.

DESCRIPTION continued on next page

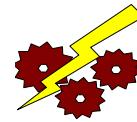


DESCRIPTION continued ...

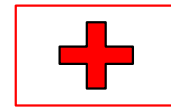
Norms

The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater for seafood processing the following norms were selected:

Mechanical/process Interferences
(Referring to problem i-ii)



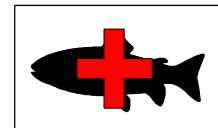
Human Health
(Referring to problem iii)



Aesthetics
(Referring to problem iv)



Biological Health
(Referring to problem v)





RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

Legend

Different water quality properties/constituents can be used to measure the effect of change in water quality for the different norms. The relevance of different water quality properties/constituents to each norm is indicated below.

The legends for the tables that follow are:
















Relevant, addressed in these documents
 Relevant, NOT addressed
 Indirectly relevant, NOT addressed
 Not relevant



NOTE: This document only addresses the relevance of properties/constituents related to *Mechanical/process interferences*. For details on the relevance of properties/constituents to the other norms refer to:

Human Health: Volume 1: Domestic Use (Fresh water)
Aesthetics: Volume 1: Domestic Use (Fresh water)
 Volume 4: Mariculture (Coastal marine)
Biological Health: Volume1: Natural Environment (Coastal marine)

Physico-chemical properties

		 Mechanical/Process Interferences
	Temperature	
	Salinity	
	pH	
	Floating matter	
	Suspended solids	
	Colour/Turbidity/ Clarity	
	Dissolved oxygen	

For more information on properties refer to:

p 4-3

p 4-6

p 4-7







p 4-9

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued on next page










RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS *continued...*

Nutrients

		 Mechanical/Process Interferences
NH_4^+	Ammonium	
NO_2	Nitrite	
NO_3	Nitrate	
PO_4	Reactive phosphate	
SiO_4	Reactive silicate	


Inorganic constituents

		 Mechanical/Process Interferences
NH_3	Ammonia	
CN	Cyanide	
F	Fluoride	
Cl_2	Chlorine	
H_2S	Hydrogen sulphide	
	Trace metals	



RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS *continued...*

Organic constituents


		 Mechanical/Process Interferences
TBT	Organotins (tributyl tin)	X
TPH	Total petroleum hydrocarbons	X
Algal	Algal toxins	X
Taint	Tainting substances	X
	Polycyclic aromatics	X
	Halogenated aliphatics	X
	Halogenated ethers	X
	Monocyclic aromatics	X
	Nitrosamines	X
	Biocides	X
	Resin acids	X
	Surfactants	X

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS *continued on next page*





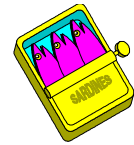
RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued...

Microbiological indicator organisms and pathogens

		 Mechanical/Process Interferences
F coli	Faecal coliform (Including <i>E. coli</i>)	X
Entero	Enterococci	X
Pathogen	Pathogens	X

Radio-active substances

		 Mechanical/Process Interferences
	Radio-active substances	X



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

NOTE: This document only addresses the effects of change in water quality (and target values) related to *Mechanical/process interferences*. For details on the effect of change in water quality (and target values) related to the other norms refer to:

Human Health:	Volume 1: Domestic Use (Fresh water)
Aesthetics (tainting):	Volume 1: Domestic Use (Fresh water)
	Volume 4: Mariculture (Coastal marine)
Biological Health:	Volume 1: Natural Environment (Coastal marine)

**Physico-chemical
properties**

Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-2
p 5-3
p 5-4
p 5-5



Chapter 2.2 Salt Production

DESCRIPTION OF USE

Use The production of salt from seawater takes place at various locations in South Africa, namely at the Swartkops estuary, the mouth of the Coega River, the Sunday's River, at Paternoster and at the Berg River. Seawater is pumped into solar ponds from where the water evaporates under the influence of wind and solar radiation, leaving increasingly higher salinity concentrations. At certain salinities, sodium chloride precipitates out and is collected, thus ensuring a high sodium chloride content in the collected product. Natural seawater has a salinity of about 35 g/l. About 22 g/l consists of sodium chloride (NaCl) while the rest consists of a large variety of other salts such as CaCl₂, MgCl₂, etc. This means that for every ton of salt, about 50 tons of seawater must be pumped into the solar ponds and evaporated. The surface area requirements are in the order of 11,5 ha of solar ponds for 1 000 tons of salt produced per year.

Effective sealing of the bottom of the solar ponds is an important requirement in the whole salt production process in order to reduce the leaching out of seawater and of the dissolved salts as much as possible. The sealing of the ponds is actually achieved by the growth of a variety of naturally occurring organisms and bacteria inside the ponds (so-called halophiles) which are also responsible for the characteristic reddish colour of these ponds.

At the Coega Salt Works near Port Elizabeth, approximately 20 000 litres of seawater are pumped in per minute, 24 hours per day, 8 months of the year. The seawater inlet pipe is equipped with a 100 mm bar screen and is positioned below the low-water level in order to avoid the intake of floating objects.

The harvested salt is subsequently washed in order to remove sediments and other foreign particles and is stockpiled. It is thereafter processed and refined to further increase the sodium chloride content and remove other salt fractions (like magnesium salt, etc.).

The salt production process, specifically the evaporation of water in the solar ponds, is inherently robust with respect to the infrequent cessation of seawater intake.

DESCRIPTION continued on next page



DESCRIPTION continued...

Problems

Problems associated with the use of seawater for salt production include:

- i. corrosion;
- ii. clogging of pumps;
- iii. excessive leaching and loss of salts;
- iv. human health problems ;
- v. tainting of salt.

At present visual inspections of the seawater take place near the inlet point and abstraction is stopped if a problem is suspected.

Because of the low cost of the end product, any additional treatment or refinement process necessary as a result of deteriorating intake water quality, would have a large impact on the economic viability of the industry.

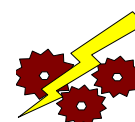
For more information on problems refer to:

- p 3-1
- p 3-2
- p 3-4

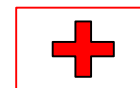
Problems vi. and v. are not addressed in further detail in this document. Details on these can be obtained from Volume 1: *Domestic Use* in the set of fresh water documents and Volumes 1 and 4: *Natural Environment* and *Mariculture* in the set of coastal marine documents

Norms

The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater for salt production the following norms were selected:



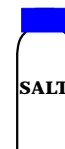
Mechanical/process Interferences
 (Referring to problems i-iii)



Human Health
 (Referring to problem iv)



Aesthetics
 (Referring to problem v)



RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

Legend

Different water quality properties/constituents can be used to measure the effect of change in water quality for the different norms. The relevance of different water quality properties/constituents to each norm is indicated below.

The legends for the tables that follow are:

Relevant, addressed in these documents
 Relevant, NOT addressed
 Indirectly relevant, NOT addressed
 Not relevant



NOTE: This document only addresses the relevance of properties/constituents related to *Mechanical/process interferences*. For details on the relevance of properties/constituents to the other norms refer to:

Human Health:	Volume 1: Domestic Use (Fresh water)
Aesthetics:	Volume 1: Domestic Use (Fresh water)
	Volume 4: Mariculture (Coastal marine)

Physico-chemical properties,
 Inorganic and organic constituents,
 Microbiological indicator organisms and pathogens,
 Radio-active substances







The relevance of physico-chemical properties, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: Seafood processing, refer to p 2-7 to p 2-10.

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued on next page



RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued...

Nutrients

		 Mechanical/Process Interferences
NH_4^+	Ammonium	
NO_2^-	Nitrite	
NO_3^-	Nitrate	
PO_4	Reactive phosphate	
SiO_4	Reactive silicate	

For information on nutrients refer to:

p 4-11

p 4-15

p 4-17

p 4-21

p 4-25



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

NOTE: This document only addresses the effects of change in water quality (and target values) related to *Mechanical/process interferences*. For details on the effect of change in water quality (and target values) related to the other norms refer to:

Human Health: Volume 1: Domestic Use (Fresh water)
Aesthetics (tainting): Volume 1: Domestic Use (Fresh water)
 Volume 4: Mariculture (Coastal marine)

Physico-chemical properties	<i>Salinity</i>	Refer to: p 5-2 p 5-3 p 5-4 p 5-5
	<i>Floating matter</i>	
	<i>Suspended solids</i>	
	<i>Colour/turbidity/clarity</i>	
Nutrients	<i>All nutrients</i>	Refer to: p 5-7



Chapter 2.3 Desalination

DESCRIPTION OF USE

Use In South Africa, most desalination plants are used for the treatment of saline effluents from industry in order to reduce discharges and recycle water within the plant.

The only desalination plants in South Africa using seawater, are small plants on South African Navy ships, commercial fishing boats and on the Moss gas platform. A pilot plant for optimising design of full-scale desalination plants has also been constructed at Lüderitz, Namibia.

Most large-scale desalination plants are found in the Middle East, Malta, etc.

The desalination process consists of a pretreatment process, followed by reverse osmosis to give a final product that will adhere to drinking water standards. The exact design of a desalination plant and the type of filters to be used for the pretreatment depend on the chemical and physical characteristics of the intake seawater.

For desalination plants to work most efficiently, a stable quality of source water is needed, and the desalination plant is specifically designed to use that particular water. Varying quality would result in reducing efficiency and increasing maintenance.

Nowadays, coastal desalination plants have moved away from direct water-intake systems, but they make use of well-points into the sediments. In cases where the quality of seawater necessitates excessive micro-filtration prior to desalination, well-points are being used instead of direct water intakes. The sediments are then used as a natural filter system in order to avoid ingress of floatables, hydrocarbons, suspended solids, etc.

The large desalination plants generally make use of long (up to 2 km) pipelines into the sea, so that seawater that is as unpolluted as possible, can be abstracted.

DESCRIPTION continued on next page



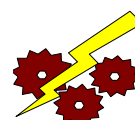
DESCRIPTION continued...

<p>Problems</p> <p>Problems associated with the use of seawater for desalination purposes include:</p> <ul style="list-style-type: none"> i. corrosion; ii. blockages of the intake system; iii. clogging of filters used in the pretreatment of water; iv. human health problems; v. tainting of the water. 	<p>For more information on problems refer to:</p> <p>p 3-1 p 3-2 p 3-2</p> <p>Problems vi. and v. are not addressed in further detail in this document. Details on these can be obtained from Volume 1: <i>Domestic Use</i> in the set of fresh water documents and Volume 4: <i>Mari-culture</i> in the set of coastal marine documents</p>
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Norms

The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater for salt production the following norms were selected:

Mechanica/process Interferences
 (Referring to problems i-iii)



Human Health
 (Referring to problem iv)



Aesthetics
 (Referring to problem v)





RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

NOTE: This document only addresses the relevance of properties/constituents related to *Mechanical/process interferences*. For details on the relevance of properties/constituents to the other norms refer to:

Human Health:	Volume 1: Domestic Use (Fresh water)
Aesthetics:	Volume 1: Domestic Use (Fresh water)
	Volume 4: Mariculture (Coastal marine)

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: *Seafood processing*, refer to p 2-7 to p 2-10.



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

NOTE: This document only addresses the effects of change in water quality (and target values) related to *Mechanical/process interferences*. For details on the effect of change in water quality (and target values) related to the other norms refer to:

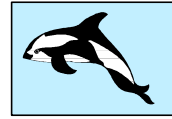
Human Health:	Volume 1: Domestic Use (Fresh water)
Aesthetics (tainting):	Volume 1: Domestic Use (Fresh water)
	Volume 4: Mariculture (Coastal marine)

**Physico-chemical
properties**

Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-2
p 5-3
p 5-4
p 5-5



Chapter 2.4 Aquariums and Oceanariums

DESCRIPTION OF USE

Use In South Africa, aquariums and oceanariums are found in Durban, East London and Port Elizabeth, while construction of a new aquarium has started in Cape Town (completion October 1995).

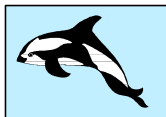
From about 10 to 100 % of the total tank volume may be replaced daily. This maintains a stable water chemical composition, and flushes away toxic wastes (notably ammonia) produced by the live specimens. It is estimated that in total about 3 000 m³ of seawater per day is needed for this purpose.

The seawater is either abstracted by means of a direct intake system at a suitable location so as to minimise ingress of floatables or sediment, and is then pumped to a sedimentation tank or filtration system, or it is abstracted by means of a well-point system. In this way, the seawater is pre-filtered, thereby strongly reducing the risk of bacteria, hydrocarbons, or marine fouling in the intake water and supply pipes.

The intake water for the aquariums may either be used untreated, chlorinated or flocculated (ferric chloride). Chlorine must be carefully removed using activated carbon before use, as it is highly toxic to fish and invertebrates.

Aquarium seawater is usually recycled and filtered. Low doses of copper sulphate (0,15 mg l⁻¹ Cu) may be added to recycled water, as an algicide and to remove pathogenic protozoa. In dolphinariums the water may be chlorinated. The dolphins can tolerate chlorine as they breathe air at the surface.

DESCRIPTION continued on next page

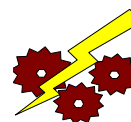


DESCRIPTION continued...

Problems	Problems associated with the use of seawater in aquariums and oceanariums include: i. corrosion; ii. blockages of the intake system; iii. unpleasant aesthetics; iv. biological health problems.	For more information on problems refer to: p 3-1 p 3-2 p 3-7 Problem iv. is not addressed in further detail in this document. Details can be obtained from Volume 1: <i>Natural Environment</i>
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Norms The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater in oceanariums and aquariums the following norms were selected:

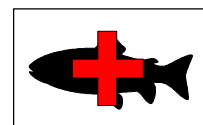
Mechanical/process Interferences
(Referring to problem i and ii)

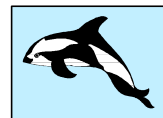


Aesthetics
(Referring to problem iii)



Biological Health
(Referring to problem iv)





RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

Legend

Different water quality properties/constituents can be used to measure the effect of change in water quality for the different norms. The relevance of different water quality properties/constituents to each norm is indicated below.





The legends for the tables that follow are:

Relevant, addressed in these documents
Relevant, NOT addressed
Indirectly relevant, NOT addressed
Not relevant



NOTE: This document only addresses the relevance of properties/constituents related to *Mechanical/process interferences and Aesthetics*. For details on the relevance of properties/constituents to *Biological Health* refer to Volume 1: Natural Environment

Physico-chemical properties

		 Mechanical/Process Interferences	 Aesthetics
°C	Temperature	✗	✗
Sal	Salinity	✓	✗
pH	pH	✗	✗
	Floating matter	✓	✓
SS	Suspended solids	✓	✓
	Colour/Turbidity/Clarity	✓	✓
O ₂	Dissolved oxygen	✗	✓...

For more information on properties refer to:

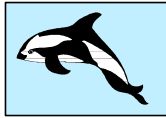
p 4-3

p 4-6

p 4-7



p 4-9

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued on next page





RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued...

Nutrients

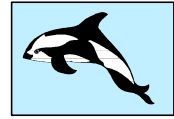
		 Mechanical/Process Interferences	 Aesthetics
NH_4^+	Ammonium	✓	✓
NO_2	Nitrite	✓	✓
NO_3	Nitrate	✓	✓
PO_4	Reactive phosphate	✓	✓
SiO_4	Reactive silicate	✓	✓

Inorganic constituents



		 Mechanical/Process Interferences	 Aesthetics
NH_3	Ammonia	✗	✗
CN	Cyanide	✗	✗
F	Fluoride	✗	✗
Cl_2	Chlorine	✗	✗
H_2S	Hydrogen sulphide	✗	✓
	Trace metals	✗	✗

For more information on inorganics refer to:

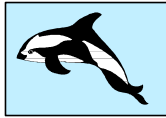
p 4-29



 RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS *continued...*
Organic constituents












		 Mechanical/Process Interferences	 Aesthetics
TBT	Organotins (tributyl tin)	X	X
TPH	Total petroleum hydrocarbons	X	X
Algal	Algal toxins	X	X
Taint	Tainting substances	X	X
	Polycyclic aromatics	X	X
	Halogenated aliphatics	X	X
	Halogenated ethers	X	X
	Monocyclic aromatics	X	X
	Nitrosamines	X	X
	Biocides	X	X
	Resin acids	X	X
	Surfactants	X	X

 RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS *continued on next page*








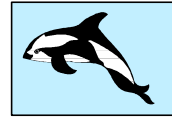
RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS *continued...*

Microbiological indicator organisms and pathogens

		 Mechanical/Process Interferences	 Aesthetics
	Faecal coliform (Including <i>E. coli</i>)		
	Enterococci		
	Pathogens		

Radio-active substances

		 Mechanical/Process Interferences	 Aesthetics
	Radio-active substances		



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

NOTE: This document only addresses the effects of change in water quality (and target values) related to *Mechanical/process interferences and Aesthetics*. For details on the effect of change in water quality (and target values) related to *Biological Health* refer to Volume 1: Natural Environment

<p>Physico-chemical properties</p> <p style="margin-left: 20px;"><i>Salinity</i></p> <p style="margin-left: 20px;"><i>Floating matter</i></p> <p style="margin-left: 20px;"><i>Suspended solids</i></p> <p style="margin-left: 20px;"><i>Colour/turbidity/clarity</i></p>	<p>Refer to:</p> <p>p 5-2</p> <p>p 5-3</p> <p>p 5-4</p> <p>p 5-5</p>
<p>Inorganic constituents</p> <p style="margin-left: 20px;"><i>Hydrogen sulphide</i></p>	<p>Refer to</p> <p>p 5-9</p>



Chapter 2.5 Harbours and Ports

DESCRIPTION OF USE

Use Much attention has lately been paid to aesthetically unattractive aspects in harbours and ports such as the presence of plastic bags and bottles, wood, oil and general jetsam and flotsam in the water. This issue only pertains to ports where major stormwater outlets enter the port. Harbours and ports, however, are primarily industrial entities. They perform an industrial function as the location for loading and offloading of goods, ores, fish, etc. and the abovementioned aspects have little impact per se on this industrial function.

When ships are in need of a new coat of paint, they are placed in a dry-dock. High-pressure water jets (150 - 250 bar) are then used to remove unwanted marine growth from the hull as well as all traces of salt from the exposed areas. The presence of salt particles between successive paint layers or between the steel and the paint layers, would result in poor bonding and the formation of rust.

For these reasons, only fresh water is used for cleaning purposes. Fresh water is also generally used for wooden boats.

Problems	Problems associated with the use of seawater in port and harbour activities include: <ul style="list-style-type: none"> i. corrosion; ii. blockage of the inlet system for seawater for shipsengines, or entanglement of driving shafts or propellers by discarded ropes, fish nets, etc.; iii. unpleasant aesthetics. 	For more information on problems refer to: <ul style="list-style-type: none"> p 3-1 p 3-2 p 3-7
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DESCRIPTION continued on next page



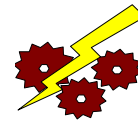
DESCRIPTION continued...

Norms

The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater in harbour and ports the following norms were selected:

Mechanical/process Interferences

(Referring to problems i and ii)



Aesthetics

(Referring to problem iii)





RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* and Aesthetics will be the same as for the use: *Aquariums and Ocenarium*, refer to p 2-25 to p 2-28.



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

**Physico-chemical
properties**

Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-2
p 5-3
p 5-4
p 5-5

Inorganic constituents

Hydrogen sulphide

Refer to:

p 5-9



Chapter 2.6 Cooling Water

DESCRIPTION OF USE

Use Presently, seawater is used as cooling water at the Koeberg nuclear plant near Cape Town. Two conventional power plants in Port Elizabeth (Swartkops) and Cape Town (Salt River) also use seawater. The one in Cape Town has, however, ceased to be operational. In addition, some smaller industrial plants depend on seawater for cooling, for example Thesen's factory in Knysna.

As at any power plant, a fuel source is used (be it uranium, coal or wood) to generate steam under high pressure. This drives the impellers of the generators, which in turn produce electricity. Cooling water is used into the condensers to condense the steam back into water which is then reheated to repeat the whole process.

The cooling water is in a totally separate system and does not come into contact with the power source or with the steam itself.

At Koeberg, approximately 80 m³ of seawater is abstracted per second at full capacity and this water is discharged again at a temperature which is about 7 - 8 EC higher than the intake water. Generally, the intake system is located below the water surface to reduce the uptake of floating debris. The intake position is also generally above the sea bottom to reduce the uptake of sediments into the pipeline.

At Koeberg, a separate basin was constructed to ensure sufficiently calm conditions to achieve this. The abstracted seawater then passes through a 100 mm bar screen and through a rotating drum screen with openings of 3 mm, to take out smaller suspended particles. Small particles and sediment can still pass through the screens, but this is not seen as problematic as these are simply recirculated through the plant and discharged again with the outlet water.

Problems	Problems associated with the use of seawater for cooling purposes include:	For more information on problems refer to:
	i. corrosion of the pipes and pumps;	p 3-1
	ii. blockages and clogging of the fine mesh of the rotating screens;	p 3-2
	iii. marine fouling or the growth of marine organisms such as mussels, etc. inside the pipelines.	p 3-3

DESCRIPTION continued on next page

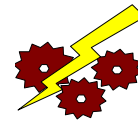


DESCRIPTION continued...

Norms

The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater for cooling purposes the following norm was selected:

Mechanical/process Interferences (Referring to problems i to iii)





RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: *Seafood processing*, refer to p 2-7 to p 2-10.



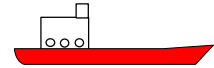
REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

**Physico-chemical
properties**

Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-2
p 5-3
p 5-4
p 5-5



Chapter 2.7 Ballast Water

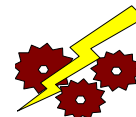
DESCRIPTION OF USE

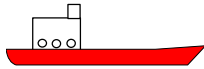
Use The ballast water of ships, stored in dedicated ballast tanks or in empty cargo holds, is used for vessel trim, stability and manoeuvrability of the vessel. At the new port of call, the ballast water is discharged and a new cargo is loaded again. As South Africa is a net exporter of raw materials such as coal and mineral ores, it receives a large amount of ballast water from overseas countries. It is estimated that the annual discharge of ballast water in South African harbours is in the order of 20 million tons, compared to about 66 million tons in Australia. It can similarly be expected that large amounts of ballast water are also taken on in South African ports and exported to other countries.

Problems	Problems associated with the intake of seawater as ballast water include: <ul style="list-style-type: none"> i. corrosion; ii. blockages of pipes and pumps; iii. intake of organisms, including marine plants, animals and pathogenic organisms that are then transported and introduced into foreign countries (not necessarily always related to deterioration of water quality). 	For more information on problems refer to: <ul style="list-style-type: none"> p 3-1 p 3-2 p 3-9
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Norms The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater for ballast water the following norm was selected:

Mechanical/process Interferences
(Referring to problems i-ii)

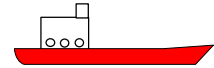




RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: *Seafood processing*, refer to p 2-7 to p 2-10.



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

**Physico-chemical
properties**

Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-2
p 5-3
p 5-4
p 5-5



Chapter 2.8 Coastal Mining

DESCRIPTION OF USE

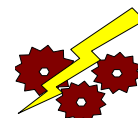
Use The only coastal mining companies that use seawater are four companies that recover alluvial diamonds along the west coast to a maximum water depth of about 150 m (at present).

The mined diamondiferous ore is generally processed on land. It is first crushed to a maximum size of about 25 mm. Seawater is used for the screening, scrubbing and washing of the ore which is then transported to a so-called Dense Medium Separation Circuit. The dense medium is made up of seawater and ferrosilica and the diamonds are separated by means of a centrifugation process. The residue together with the seawater, goes to a slimes dam, after which the ferrosilica is abstracted and used again.

The seawater intake system is generally located below low-water and is equipped with a bar screen to remove the larger particles. The seawater is then pumped to a settling dam where most of the sediments are eliminated from the water, after which it is used in the recovery process. A rough estimate of the amount of seawater used would be in the order of about 2 million cubic metres per month.

Problems	Problems associated with the use of seawater in coastal mining include:	For more information on problems refer to:
	i. corrosion;	p 3-1
	ii. blockages in the spraying nozzles used for cleaning and washing the diamondiferous ore;	p 3-2
	iii. marine fouling in the pipelines.	p 3-3

Norms The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater in coastal mining, the following norm was selected:



Mechanical/process Interference
(Referring to problems i-iii)



RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: *Seafood processing*, refer to p 2-7 to p 2-10.



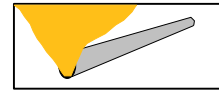
REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

**Physico-chemical
properties**

Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-2
p 5-3
p 5-4
p 5-5



Chapter 2.9 Make-up Water for Marine Outfalls

DESCRIPTION OF USE

Use Marine outfalls are generally designed for a 30 - 40 year lifespan. It is obvious that the effluent quantity discharged through these outfalls can increase significantly over such a long period, and the diameter of the outfall must be such that it can cope with the eventual effluent volume. This means that initially the outfall will be too large for the actual effluent quantity. This problem can be overcome by two different approaches; the effluent is either discharged intermittently (e.g. a five-minute discharge every 15 minutes) or seawater is added to the effluent stream to increase the quantity.

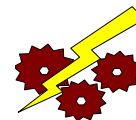
In South Africa, seawater is only used for the latter purpose in Richards Bay on the two marine outfalls operated by Mhlathuze Water. The two outfalls discharge on average 117 000 m³ of industrial effluent per day, to which about 85 000 m³ of seawater are added.

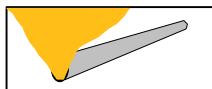
Fresh water is presently used as service water for the glands of the pump system. Mhlathuze Water is considering using seawater for this purpose.

Problems	Problems associated with the use of seawater as make-up water for marine outfalls include: <ul style="list-style-type: none"> i. corrosion; ii. blockage of the inlet works; iii. interference with nett positive suction head of the pumps. 	For more information on problems refer to: p 3-1 p 3-2 p 3-5
-----------------	---	---

Norms The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater in coastal mining the following norm was selected:

Mechanical/process Interferences
 (Referring to problems i-iii)





RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

Legend
















Different water quality properties/constituents can be used to measure the effect of change in water quality for the different norms. The relevance of different water quality properties/constituents to each norm is indicated below.

The legends for the tables that follow are:

Relevant, addressed in these documents
 Relevant, NOT addressed
 Indirectly relevant, NOT addressed
 Not relevant



Physico-chemical properties

		 Mechanical/Process Interferences
	Temperature	
	Salinity	
	pH	
	Floating matter	
	Suspended solids	
	Colour/Turbidity/ Clarity	
	Dissolved oxygen	

For more information on properties refer to:

p 4-1

p 4-3

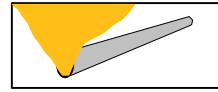
p 4-6

p 4-7

p 4-9

Other constituents

The relevance of ALL other water quality constituents, i.e. nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: *Seafood processing*, refer to p 2-7 to p 2-10.



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

**Physico-chemical
properties**

Temperature
Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-1
p 5-2
p 5-3
p 5-4
p 5-5



Chapter 2.10 Exploratory Drilling

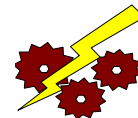
DESCRIPTION OF USE

Use Soekor is carrying out exploratory drilling tests in various areas around the South African coastline (Mossel Bay, Breda Basin, west coast) at distances of up to 100 km from the coastline, for the purpose of locating payable reserves of hydrocarbons (oil and gas). At Mossel Bay, seawater is used for the drilling of the first 200 - 300 m of each test hole. Afterwards fresh water is used, as the salinity of the deeper layers is very close to that of fresh water.

The seawater is abstracted directly from the drilling platform and ingress of floatables and larger particles is prevented by using a coarse screen.

Problems	Problems associated with the use of seawater in coastal mining include: <ul style="list-style-type: none"> i. corrosion; ii. blockages of pipes. 	For more information on problems refer to: p 3-1 p 3-2
-----------------	--	--

Norms The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater in exploratory drilling, the following norm was selected:



Mechanical/process Interferences
 (Referring to problems i-ii)



RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: *Seafood processing*, refer to p 2-7 to p 2-10.



REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

**Physico-chemical
properties**

Salinity
Floating matter
Suspended solids
Colour/turbidity/clarity

Refer to:

p 5-2
p 5-3
p 5-4
p 5-5

SCALING/SCRUBBING

Chapter 2.11 Scaling and Scrubbing

DESCRIPTION OF USE

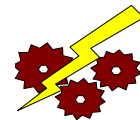
Use In Richards Bay, Alusaf is abstracting seawater from a canal towards the western end of the harbour area. Approximately 50 000 m³ per day are used for scrubbing smoke stack emissions. Seawater is pumped to the top of the stacks and the smoke emissions are passed through the seawater in order to remove the dust particles from these emissions. The water is then returned to the harbour area.

Pretreatment of the seawater consists of a mesh screen that removes all particles more than 2 mm diameter. The intake water is not chlorinated.

A dry scrubbing process is presently being installed and will be operational from July 1995.

Problems	Problems associated with the use of seawater for scaling and scrubbing include:	For more information on problems refer to: p 3-1 p 3-2 p 3-2
	i. corrosion;	
	ii. blockages of the intake system, pumps, screens and pipelines;	
	iii. clogging of screens.	

Norms The quality of water can be described in terms of many different properties or constituents. It is therefore important to select specific norms upon which to base the selection of relevant water quality properties/constituents for a particular use or user group. Norms can also be described as types or 'boxes' of problems associated with a particular use of seawater. Considering the use of seawater for scaling and scrubbing, the following norm was selected:



Mechanical/process Interferences
 (Referring to problems i-iii)

SCALING/SCRUBBING

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic and organic constituents, microbiological indicator organisms and pathogens and radio-active substances related to *Mechanical/process interferences* will be the same as for the use: *Seafood processing*, refer to p 2-7 to p 2-10.

SCALING/SCRUBBING

REFERENCES TO EFFECTS OF CHANGE (REFER TO SECTION 5)

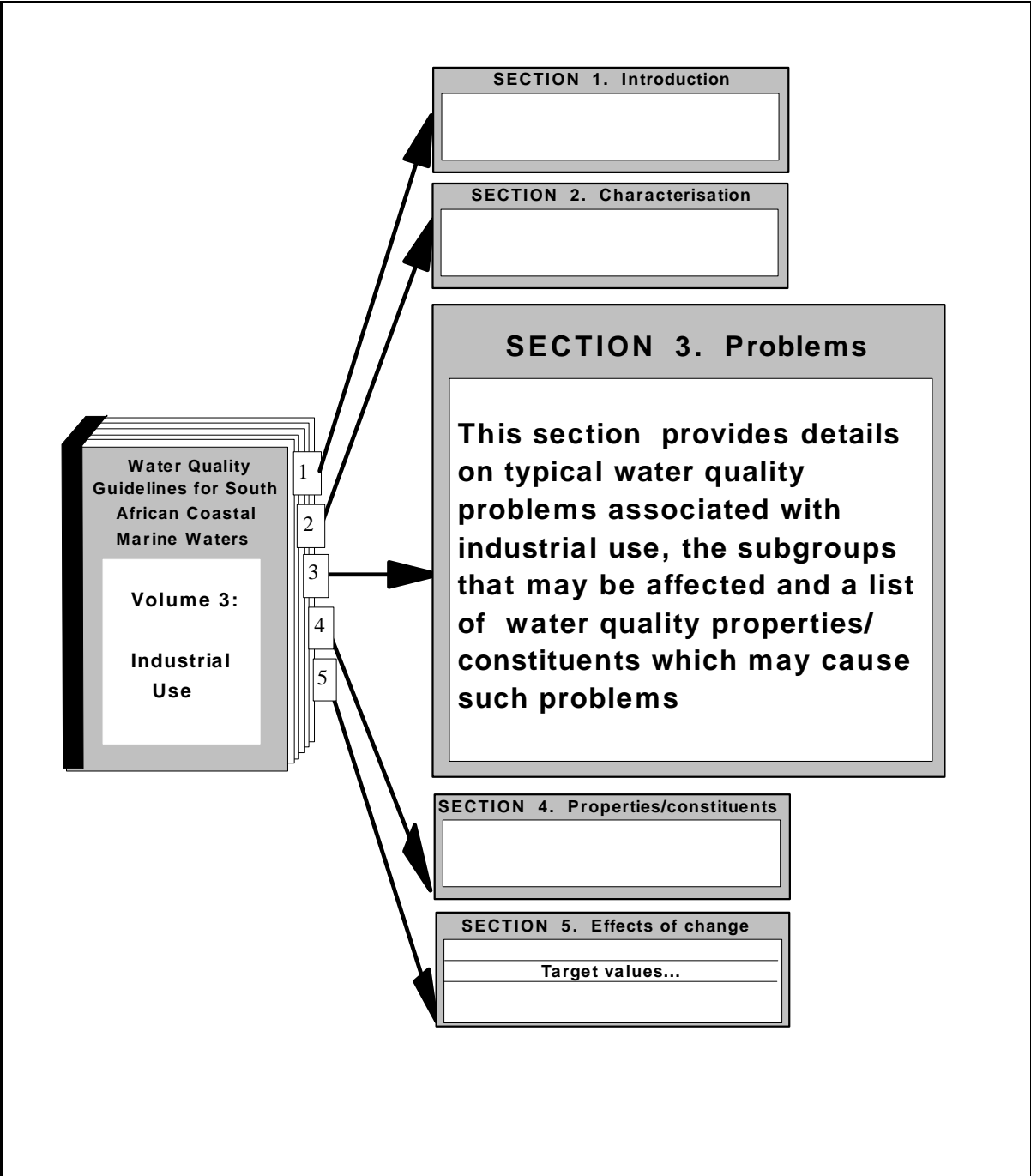
**Physico-chemical
properties**

- Salinity*
- Floating matter*
- Suspended solids*
- Colour/turbidity/clarity*

Refer to:

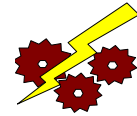
- p 5-2
 - p 5-3
 - p 5-4
 - p 5-5
-

SECTION 3: TYPICAL WATER QUALITY PROBLEMS ASSOCIATED WITH INDUSTRIAL USE OF SEAWATER



SECTION 3: PROBLEMS CONTENTS

Chapter 3.1	Mechanical/process Interferences	3-1
	Corrosion	3-1
	Clogging and blockage of equipment	3-2
	Marine fouling or growth of organisms	3-3
	Excessive leaching and loss of salts	3-4
	Interference with suction heads of pumps	3-5
Chapter 3.2	Aesthetic Factors	3-7
	Unpleasant aesthetics	3-7
Chapter 3.3	Biological Health	3-9
	Introduction of foreign organisms	3-9



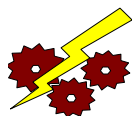
Chapter 3.1 Mechanical/process Interferences

CORROSION

Description Certain metals have a tendency to corrode when immersed in water, especially soft or acidic water or seawater, i.e. corrosion of certain metals occur in a weak electrolyte solution such as seawater.

Related sub-groups	Corrosion may be associated with <i>all industrial uses</i> where metallic equipment, not suitable for seawater, is used.	For more information on the subgroups refer to Section 2
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Related properties/ constituents and effects of change in water quality	Corrosion is usually associated with high <i>salinities</i> No data could be obtained on specific concentration ranges and problems.	For more information on salinity refer to p 4-3
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CLOGGING AND BLOCKAGE OF EQUIPMENT

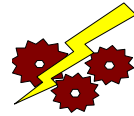
Description This problem refers to the mechanical interferences that occur when objectionable matter such as litter, oil and grease, debris, etc. clog and block equipment such as engines and pumps.

Related subgroups Clogging and blockages may occur with all industrial uses of seawater where pipes, pumps, screens, etc. may be used.

For more information on the subgroups refer to Section 2

Related properties/ constituents and effects of change in water quality Clogging and blockages are usually occur as a result of objectionable *floating matter*, *suspended solids* and *turbidity* being present. No data could be obtained on specific concentration ranges and problems.

For more information on properties/ constituents refer to Section 4.



MARINE FOULING OR GROWTH OF ORGANISMS

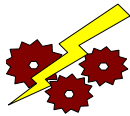
Description This problem refers to marine algae and other organisms settling on structures in the marine environment, thus effectively reducing the performance of such equipment or structures.

Related subgroups	<p>Marine fouling is a potential problem in industrial uses where equipment and pipes are fixed structures within marine waters, thus allowing marine communities to settle. These industrial uses include:</p> <ul style="list-style-type: none"> - seafood processing; - aquariums and oceanariums; - harbours and ports - cooling water; - coastal mining. 	<p>For more information on the uses refer to:</p> <p>p 2-3 p 2-23 p 2-31 p 2-35 p 2-43</p>
--------------------------	--	--

Related properties/constituents Marine fouling or the settlement of organisms on equipment and structures in marine waters usually does not occur as a result of deterioration of water quality. It is rather due to the fact that these structures create suitable habitats for these communities to settle on. For example, old ships have been used to create artificial habitats for the establishment of reef communities along the South African coast.

In most instances, this problem is overcome by the addition of chlorine to the intake water at a concentration of 1 mg l^{-1} . This concentration is not enough to kill the mussels, but is sufficient to prevent the mussels settling inside the pipes.

However, the addition of chlorine (and subsequent treatment with activated carbon) to water used for aquariums seems a very dangerous procedure since the total die-off of aquarium animals has occurred in the past. Treatment with copper sulphate is generally preferred.



EXCESSIVE LEACHING AND LOSS OF SALTS

Description In the salt production process, effective sealing of the bottom of the solar ponds is an important requirement. This is achieved by the growth of a variety of naturally occurring organism and bacteria inside the ponds. Excessive leaching and loss of salts occur when the natural balance of these organisms is upset.

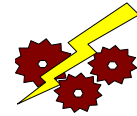
Related subgroups This problem is specifically related to *Salt production*.

For more information
on use refer to p 2-13

**Related properties/
constituents and
effects of change
in water quality** This problem is usually caused when seawater with high *nutrient* concentrations is introduced to the solar ponds.

No data could be obtained on specific concentration ranges and problems.

For more information on
nutrients refer to p 4-
11 to p 4-25



INTERFERENCE WITH SUCTION HEADS OF PUMPS

Description This problem refers to the loss of nett positive suction of pumps resulting in a reduction in the capacity of these pumps.

Related subgroups	This problem is mainly related to the use of seawater as <i>make-up water in marine outfall</i> systems.	For more information on use refer to p 2-47
--------------------------	--	---

Related properties/ constituents and effects of change in water quality	This problem is usually associated with changes in water <i>temperature</i> . Information on the effect of specific temperatures is provided in Section 5.	For more information on temperature refer to p 4-1 Refer to p 5-1
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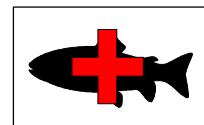
Chapter 3.2 Aesthetic Factors

UNPLEASANT AESTHETICS

Description This problem generally refers to aesthetically unpleasant conditions which may occur, e.g. unpleasant odours, discolouration of the water and the presence of objectionable matter.

Related uses	Aesthetic problems may be associated with <i>aquariums and oceanariums</i> and <i>harbour and ports</i> .	For more information on the uses refer to p 2-23 and p 2-31
---------------------	---	---

Related properties/ constituents and effects of change in water quality	Unpleasant aesthetic conditions are usually caused by the presence of objectionable matter, such as <i>floating matter</i> , <i>suspended solids</i> , <i>colour/turbidity</i> and malodorous substances such as <i>hydrogen sulphide</i> . Detailed information on the effects of specific amounts or concentrations could not be obtained.	For more information on temperature refer to Section 4.
--	---	---



Chapter 3.3 Biological Health

INTRODUCTION OF FOREIGN ORGANISMS

Description This problem refers to the introduction of marine plants and animals as well as pathogens into foreign countries.

Related subgroups This problem is related to the intake of seawater as *ballast water* in ships.

For more information
on use refer to p 2-39

**Related properties/
constituents and
effects of change**

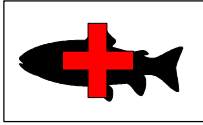
This problem is not necessarily as a result of a deterioration in water quality. Although the introduction of harmful *pathogens* may be linked to this problem, it is mainly caused by the introduction of exotic organisms when ballast water taken from one part of the ocean gets discharged into another. In this way, the natural ecological balance is upset, resulting in a variety of secondary problems. There is increasing concern both nationally and internationally that a wide variety of organisms, including pathogens (as well as marine plants and animals), have been transported in the ballast water of ships and introduced into foreign countries. Apart from ecological damage, this has resulted in both public health and economic implications. The introduction of toxic dinoflagellates (responsible for red tides) which can contaminate shellfish and make them toxic to human consumption, is of particular concern and can cause considerable damage to the mariculture industry. These species further have the ability to produce resistant spores (cysts) that can be readily transported in ballast water sediment. *There is an additional consideration that ports exporting ballast water containing potentially harmful organisms, could be held liable for any subsequent damage.* While the possibility of upholding such liability might be questionable, there would be no harm in guarding against it.

Where applicable, it is suggested that ballast water be abstracted as high as possible in the water column in order to prevent ingress of sediments.

Where applicable, it is recommended that ships re-ballast in open water in order to take on new, fresh seawater which is free from such organisms.

Once the translocated marine species have become established and develop into reproducing populations (maybe replacing indigenous species), the effect is of a permanent nature.

INTRODUCTION OF FOREIGN ORGANISMS continued on next page



INTRODUCTION OF FOREIGN ORGANISMS continued...

NOTE:

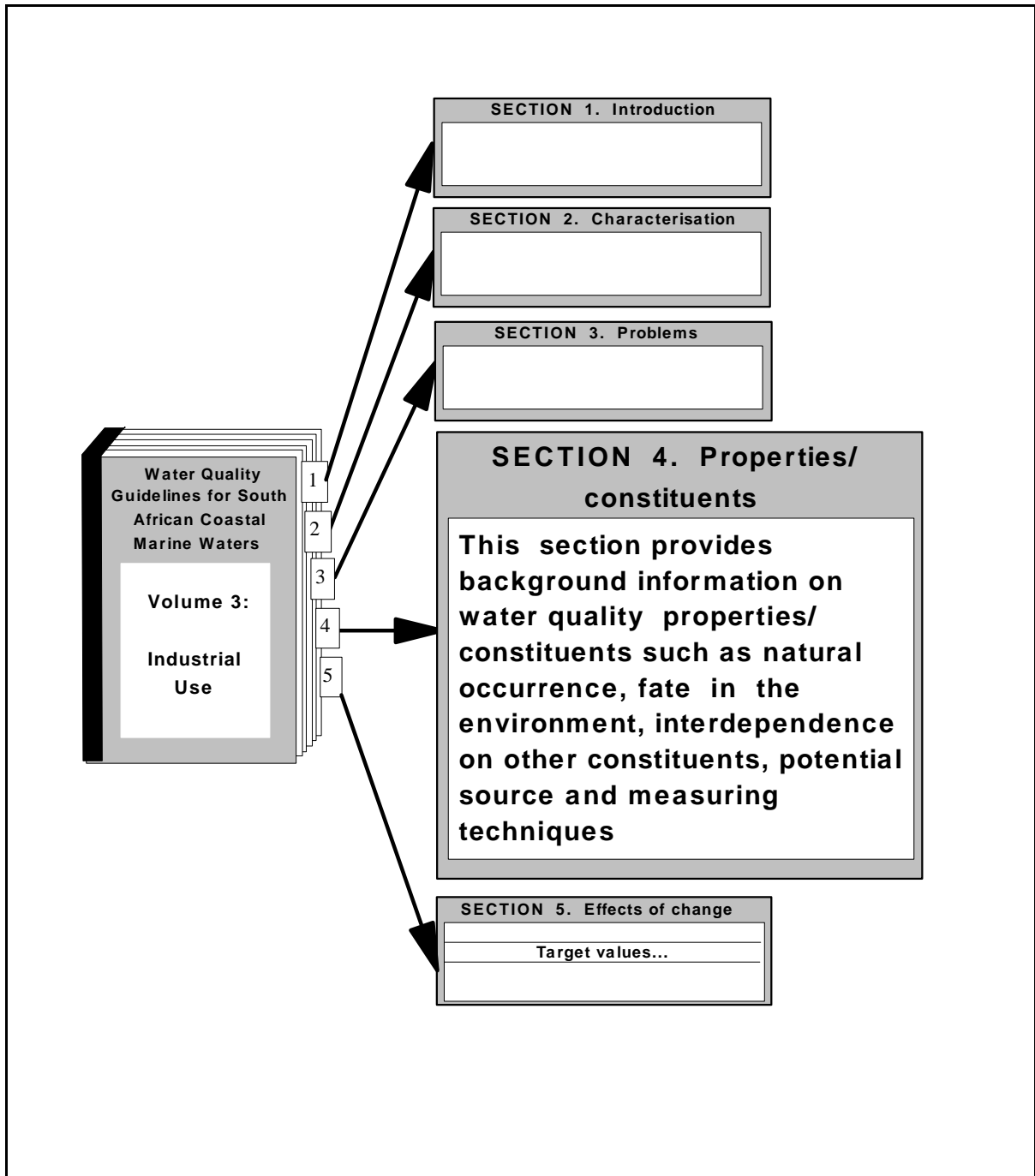
A number of overseas countries such as Canada, America, Australia and New Zealand have introduced voluntary guidelines to control the discharge of ballast water into their coastal waters. These voluntary guidelines are generally regarded as a first step towards the introduction of mandatory international controls.

In 1991, the Marine Environment Protection Committee of the International Maritime Organisation adopted recommendations on International Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ship's Ballast Water and Sediment Discharges, as resolution MEPC 50(31). It is the intention that these guidelines form the basis for a new technical annex to the MARPOL Convention to which South Africa is a signatory. The above guidelines acknowledge that '... port states and administrations have a responsibility to ensure that ballast water, loaded in their ports and harbours, does not contain plants, animals or pathogens that pose a threat to the waters of other states.'

The guidelines furthermore make the following statement:

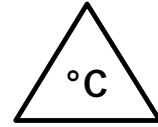
'When loading ballast, every effort should be made to ensure that only clean ballast water is being taken on and that the uptake of sediment with the ballast water is minimised. Where practicable, ships should endeavour to avoid taking on ballast water in shallow water areas, or in the vicinity of dredging operations, to reduce the likelihood that the water will contain silt, which may harbour the cysts of unwanted aquatic organisms and pathogens, and to otherwise reduce the probability that unwanted aquatic organisms and pathogens are present in the water. Areas where there is a known outbreak of diseases, communicable through ballast water, or in which phytoplankton blooms are occurring, should be avoided wherever practicable as a source of ballast.'

SECTION 4: BACKGROUND INFORMATION ON WATER QUALITY PROPERTIES/ CONSTITUENTS RELATED TO INDUSTRIAL USE OF SEAWATER



SECTION 4: BACKGROUND INFORMATION ON WATER QUALITY PROPERTIES/CONSTITUENTS CONTENTS

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Chapter 4.1 Physico-chemical Properties

TEMPERATURE

Description Temperature is a basic property of water. Temperature, or changes in temperature, is important in the regulation or triggering of many physiological processes in marine organisms.

Natural occurrence The temperature regime for South African marine waters differs from one coastal region to another:

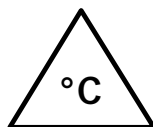
West coast. Generally, the natural temperature regime along the west coast is largely influenced by wind-induced upwelling (south-easterly and southerly winds) which varies seasonally. Seasonality is strongest in the south where south-easterly winds are rare in winter but common in summer. Seasonality diminishes to the north-west where the wind generally comes from the south throughout the year although velocities are lower in winter^(1,2). Temperatures of the upwelled waters range from 9 °C - 14 °C, depending upon the 'strength' of the upwelling process⁽¹⁾. These temperatures can increase to 16 °C and higher through sun warming after being upwelled⁽⁴⁾. The mixed water is bounded by an oceanic front which lies at or slightly offshore of the shelf break⁽⁵⁾. Temperatures of oceanic water in the area are about 20 °C⁽¹⁾.

South coast. Surface temperatures over most of the south coast are usually between 20-21 °C during summer and 16-17° C during winter. During summer, thermoclines are formed by the sun heating the surface water, while during winter months the water column is generally well mixed. Upwelling may also influence the temperature regime in the coastal zone, albeit not on the same scale as along the west coast⁽⁷⁾.

East coast. The waters of the east coast are of tropical origin with a maximum of 25 EC occurring in February in inshore waters. The difference between summer and winter averages 4 EC with a generally well mixed regime. Further offshore, there is also a 4 EC change between summer and winter in the upper 50 m with summer maxima greater than 26 EC. At lower depths, seasonal variation is apparently not evident. However, short-term fluctuations in surface waters may be as high as 8-9 EC, often exceeding seasonal variations. There is evidence of localised upwelling on the inner shore occurs along various areas of the coastline⁽⁸⁾.

Although this section gives an indication of the temperature ranges found within the different coastal regions, detailed temperature regimes are very site specific. Detailed temperature data sets for a large selection of sites along the South African coast can be obtained from the South African Data Centre for Oceanography (SADCO), CSIR, Stellenbosch.

TEMPERATURE continued on next page



TEMPERATURE continued...

Fate in environment	Not relevant to temperature.	
Interdependence on other constituents	Generally, temperature is not interdependent on any other water quality properties or constituents.	
Measurement in seawater	<p>For marine waters, temperature is usually measured <i>in situ</i>, using a Conductivity-Temperature-Depth-Salinity (CTDS) meter. An ordinary thermometer can also be used.</p> <p>Units: °C.</p>	
Pollution sources	<p>Anthropogenic sources which may influence water temperature in the marine environment are usually related to the discharge of cooling water from power stations and certain industries⁽⁹⁾.</p>	
Treatability	<p>Where seawater is used in enclosed systems, e.g. aquariums and mariculture activities, heat exchangers can be used. The type of metal used in the heat exchanger should be chosen carefully. Generally, titanium is preferred in seawater⁽¹⁰⁾.</p>	
Related problems	<p>Typical water quality problems which may be associated with temperature, and which are addressed in this document, include:</p> <ul style="list-style-type: none"> - interference with suction heads of pumps. 	<p>For more details on problems refer to:</p> <p>p 3-5</p>
Effects of change and target values	<p>Factual information on the effect of different temperature ranges on industrial uses, as well as target values, are provided in Section 5 for:</p> <ul style="list-style-type: none"> - make-up water for marine outfalls. 	<p>Refer to:</p> <p>p 5-1</p>



SALINITY

Description Salinity refers to the dissolved salt content in seawater. Typically, the major constituents in 1 kg of average seawater with a salinity of 35×10^{-3} is ⁽¹¹⁾:

Na ⁺	-	10,78 g
Mg ²⁺	-	1,28 g
Ca ²⁺	-	0,41 g
K ⁺	-	0,40 g
Sr ²⁺	-	0,01 g
Cl ⁻	-	19,35 g
SO ₄ ²⁻	-	2,71 g
HCO ₃ ⁻	-	0,11 g
Br ⁻	-	0,07 g
CO ₃ ⁻	-	0,01 g
B(OH) ₄ ⁻	-	0,001 g
B(OH) ₃ ⁻	-	0,02 g

Natural occurrence The salinity regime for South African marine waters differs from one coastal region to another:

West coast. Salinities fall in the narrow range of $34,7 \times 10^{-3}$ to $35,4 \times 10^{-3}$; the lower salinities being associated with cold upwelling water ⁽¹⁾. Land run-off is low and intermittent and thus dilution of these salinities only occurs in very localised areas, e.g. the Berg River mouth and the smaller estuaries further south. Due to evaporative loss, salinities as high as $37,0 \times 10^{-3}$ have been recorded in Langebaan lagoon ⁽¹²⁾.

South coast. Salinities measured in coastal water of the south coast have revealed slight seasonal variations with highest salinities in summer ($35,4 \times 10^{-3}$) and lowest values in winter ($35,0 \times 10^{-3}$) ⁽¹³⁾.

East coast. Subtropical surface waters are usually characterised by relatively high salinities ($>35 \times 10^{-3}$) caused by greater evaporation rates. However, input of fresh water from large rivers to the north (Zambezi and Limpopo) as well as input from east coast rivers results in slightly reduced summer salinities. There is generally a slight positive salinity gradient from the shoreline to the core of the Agulhas current ⁽⁸⁾.

Fate in environment Not relevant to salinity.

SALINITY continued on next page



SALINITY continued...

Interdependence on other constituents Generally, salinity is not interdependent on other water quality properties or constituents.

Measurement in seawater In marine waters, salinity is usually measured *in situ*, using a Conductivity-Temperature-Depth-Salinity (CTDS) meter.

According to *The International System of Units (SI) in Oceanography* salinity's unit is dimensionless, being the ratios between two electrical conductivities.

The practical salinity of a sample of seawater is defined in terms of the conductivity ratio, K_{15} , which is defined by⁽¹⁴⁾:

conductivity of seawater sample at 15 °C, 1 atm pressure and the standard
conductivity of standard KCl solution KCl solution being 32,4356 g kg⁻¹

Where the ionic strength ('salt content') of seawater has been measured as Electrical Conductivity (EC), mS m⁻¹, conversion factors can be used. Conversion factors from EC to salinity in the range of 32x10⁻³-36x10⁻³, at different temperatures are⁽¹⁶⁾:

ELECTRICAL CONDUCTIVITY (mS m ⁻¹)	TEMPERATURE (°C)			
	25	20	15	10
5 437,4	6,62			
5 302,5	6,60			
5 167,1	6,58			
5 031,4	6,56			
4 895,1	6,54			
4910,5		7,33		
4 788,2		7,31		
4 665,6		7,29		
4 542,6		7,26		
4 419,2		7,24		
4 399,6			8,18	
4 289,6			8,16	
4 179,4			8,13	
4 068,8			8,11	
3 957,9			8,08	
3 906,1				9,22
3 808,0				9,19
3 709,6				9,16
3 611,0				9,14
3 512,2				9,11

Conversion: $\text{Salinity} \times 10^{-3} = \frac{\text{EC (mS m}^{-1}) \times \text{factor}}{1\ 000}$

SALINITY continued on next page



SALINITY continued...

Measurement
continued... Where the salt content has been measured as mg l⁻¹ Total Dissolved Solids (TDS), it can be converted to salinity by dividing the TDS value by 1 000.

Pollution sources Anthropogenic influences on salinity in the marine environment are usually related to waste discharges (fresh water) which, depending on the volume discharged, may result in a short-term decrease in salinity in the immediate vicinity of the discharge.

Treatability Where seawater is used in an enclosed system, e.g. aquariums, salinity is often elevated due to evaporation. This is usually 'treated' by adding fresh water.

Related problems	Typical water quality problems which may be associated with salinity, and which are addressed in this document include:		For more details on problems refer to:
			p 3-1
	- corrosion.		

Effects of change and target values Factual information on the effect of different salinity ranges on industrial uses could not be obtained.

The natural salinity of seawater will, however, result in corrosion problems.



FLOATING MATTER

Description Floating matter refers to debris, oil, grease, wax, scum, foam, submerged (just below water surface) objects or any other visible substances.

Natural occurrence Naturally occurring floating matter is usually limited to macrophytes and algae.

Fate in environment Objectionable floating matter may end up on beaches or in sheltered areas where it becomes an aesthetic problem. It may also result in smothering or physical injury to marine life, e.g. benthic communities, sea birds and seals.

Interdependence on other constituents Not relevant to floating matter.

Measurement in seawater Floating matter is not usually measured quantitatively in marine waters, but is rather 'measured' in terms of a qualitative description.

Pollution sources Anthropogenic sources of objectionable floating matter include:

- raw sewage (municipal waste);
 - stormwater run-off (litter and debris);
 - accidental oil spills (oil and grease);
 - paper and pulp waste water (foaming);
 - illegal dumping of ship refuse.
-

Treatability Treatment is usually limited to the physical removal of objectionable floating matter, either through coarse grid systems or otherwise manually.

Related problems Typical water quality problems which may be associated with the presence of objectionable floating matter include:

- clogging and blockage of equipment.

For more details on problems refer to:

p 3-2

Effects of change and target values Information on the effects of objectionable floating matter on industrial uses, as well as target ranges, are provided in Section 5 for:

- all industrial uses.

Refer to:

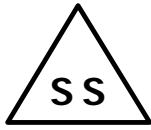
p 5-3



SUSPENDED SOLIDS

Description	Suspended solids refer to particulate inorganic and organic matter that are in suspension in the water column. The presence of suspended solids is usually attributed to a reduction in the clarity of water, i.e. light penetration or visibility. Under calm conditions suspended solids may settle from the water column to form objectionable deposits.
Natural occurrence	<p>Naturally occurring suspended materials include finely divided organic and inorganic matter, plankton and other microscopic organisms. These are usually more evident during stormy conditions, plankton blooms and large river run-off.</p> <p>Suspended solids may also be introduced to the water column through resuspension of natural debris during turbulent conditions, usually caused by strong wind and wave action.</p>
Fate in environment	Suspended solids are usually kept in suspension since their density is similar to that of seawater and turbulence in the water column. Under calmer conditions, solids may settle out from the water column and be deposited onto the sediments.
Interdependence on other constituents	Information on the interdependence of suspended solids on other water quality constituents or properties could not be obtained.
Measurement in seawater	<p>Suspended solids can be determined by collecting the suspended matter from a known volume of water (usually one litre) onto GF/C glass fibre filter paper⁽¹⁷⁾.</p> <p>Units: mg l⁻¹.</p>
Pollution sources	<p>Anthropogenic sources of suspended solids include:</p> <ul style="list-style-type: none"> - storm water run-off; - sewage discharges; - industrial waste.

SUSPENDED SOLIDS continued on next page



SUSPENDED SOLIDS continued...

Treatability Suspended solids with a diameter of greater than 60 µm can be removed from seawater by using filters, e.g. sand filters.

Related problems	Typical water quality problems which may be associated with suspended solids include:	For more details on problems refer to: p 3-2
	- clogging and blockage of equipment.	

Effects of change and target values	Information on the effects of suspended solids on industrial uses, as well as target values, are provided in Section 5 for:	Refer to: p 5-4
	- all industrial uses.	



COLOUR/TURBIDITY/CLARITY

Description The turbidity, colour and clarity of water are properties which are usually strongly linked to one another. Turbidity is caused by colloidal suspensions (particle size between 0,001 μm and 0,1 μm) which usually give water a 'murky' appearance, while colour is caused by substances which dissolve in water, and as a result the colour of the water changes. Both turbidity and colour, together with suspended solids, influence the clarity of water, i.e. the depth of light penetration or visibility in water. A constituent which may affect these properties of water is gypsum (calcium sulphate with two waters of hydration [$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$]), a waste product of fertilizer industries.

Natural occurrence Natural turbidity in water is caused by colloidal suspension (particle size between 0,001 μm and 0,1 μm) of, for example, clays and silt, usually introduced through river run-off. Turbidity may also be introduced to the water column through re-suspension of natural debris during turbulent conditions, usually caused by strong wind and wave action. Natural colour in water may result from the presence of natural metallic ions and humic substances, usually introduced through river run-off.

In the natural environment, gypsum only starts to precipitate from seawater at a salinity of 117×10^{-3} (e.g. through evaporation) ⁽⁵⁵⁾.

Fate in environment Owing to the high salt content of seawater, natural colloidal suspension (causing turbidity) and humic substances (natural colour) usually coagulate with specific ions and precipitate out.

Interdependence on other constituents Turbidity and colour may be influenced by the salinity of water (see *Fate in Environment*).

The solubility product (K_{sp}) of gypsum in seawater is a function of the ionic strength (I), the solubility product at zero ionic strength (K_{sp}^0) and a number of other factors ^(25,56). For example, the solubility product and the solubility (in g l^{-1}) of gypsum at 25 °C for different salinities are:

Salinity	K_{sp}	Solubility (g l^{-1})*
20×10^{-3}	0,0009	5,3
25×10^{-3}	0,0011	5,8
30×10^{-3}	0,0013	6,2
35×10^{-3}	0,0014	6,6

*Solubility (g l^{-1}) = $\sqrt{K_{\text{sp}}}$ multiplied by the molecular mass of gypsum (172,17) multiplied by the density of seawater at 25 °C (1,023)

COLOUR/TURBIDITY/CLARITY continued on next page



COLOUR/TURBIDITY/CLARITY continued...

Measurement in seawater

Turbidity can be measured on a Turbidimeter (Nephelometer) ⁽¹⁷⁾.

Units: NTU (Nephelometric turbidity units)

'True colour', i.e. the colour in water caused by substances in solution, can be measured through visual comparison method such as the platinum cobalt method or on a Lovibond comparator ⁽¹⁷⁾.

Units: Pt-Co mg l⁻¹ (defined as the colour being produced by 1 mg Pt l⁻¹ in the form of the chloroplatinate ion) or Hazen unit .
 (1 Hazen unit = 1 Pt-Co mg l⁻¹)

The clarity of water (combined effect of colour, turbidity and suspended solids) can be measured by using a Secchi disc.

Units: metres below water surface.

Pollution sources

Anthropogenic sources of colour/turbidity include:

- industrial waste, e.g. paper and pulp and textile industries;
- raw sewage discharges;
- waste from fertilizer industries (gypsum).

Treatability

Activated carbon filters can be used to remove turbidity or colour, although, depending on the volume of water, this can be very expensive.

Related problems

Typical water quality problems which may be associated with the presence of objectionable colour/turbidity/clarity include:

- clogging and blockage of equipment.

For more details on problems refer to:

p 3-2

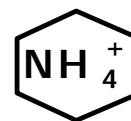
Effects of change and target values

General effects of colour/turbidity/clarity on industrial uses, as well as target values, are provided in Section 5 for:

- all industrial uses.

Refer to:

p 5-5



Chapter 4.2 Nutrients

AMMONIUM (also AMMONIA)

Description In aqueous solution ammonia is present in two forms, ionised (NH_4^+) and un-ionised (NH_3).



NH_3 is regarded as the toxic form of ammonia because it is uncharged and lipid soluble, whereas hydrated ammonium ions (NH_4^+) are non-toxic and serve as a nutrient to primary producers. The permeability of plasma membranes to charged particles, such as ammonium ions, is relatively low ⁽²⁰⁾.

Natural occurrence In oxygenated unpolluted seawater samples, the amounts of NH_4^+ -N and NO_3^- -N rarely exceed $70 \mu\text{g N l}^{-1}$, but in deep anoxic stagnant water, such as in the Black Sea, the amount of NH_4^+ -N can be as high as $2\ 100 \mu\text{g l}^{-1}$ ⁽²³⁾.

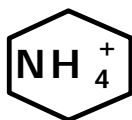
The concentration of ammonia in the seawater shows considerable variations and can change rapidly. The ionic state is highly dependent on pH, temperature and salinity (refer to *Interdependence on other constituents*, p 4-13).

Ammonia is excreted directly by animals together with urea and peptides ⁽²³⁾.

Fate in environment Ammonia is often the most abundant form of inorganic nitrogen in the surface layers after a period of productivity when the phytoplankton blooms have removed the greater part of nitrate and phosphate. In the assimilation processes of phytoplankton, ammonium is preferentially used for synthesising protein. When nitrate is incorporated it must first be reduced to ammonia before it can be transferred into amino acid compounds ⁽²³⁾.

Soluble and particulate organic nitrogen compounds resulting from decaying organisms together with those excreted by plants and animals are rapidly broken down to NH_3 by various species of proteolytic bacteria ⁽²³⁾.

AMMONIUM continued on next page



AMMONIUM continued...

Fate in environment
continued...

When organisms sink below the euphotic zone, they decompose as a result of oxidative bacterial action releasing nitrate and phosphate. As the water approaches anoxic conditions, bacteria utilise the nitrate ions to continue the oxidation process. This denitrification leads to the production of molecular nitrogen and ammonium. Interaction between nitrate and ammonia produces more nitrogen gas. At the onset of sulphate reduction, ammonia and hydrogen sulphide are often produced in high concentrations⁽²³⁾.

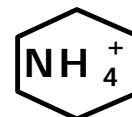
Ammonia-nitrogen is the dominant form of combined inorganic nitrogen when anoxic conditions have developed to the stage when all the nitrate-nitrogen has been reduced, and if the system becomes anoxic, the concentration of ammonia-nitrogen can become high. Dead or senescent algal cells will autolyse, and this effect coupled with bacterial action will release ammonia-nitrogen, a large proportion of the organic nitrogen originally bound in particulate form. For aquatic animals ammonia-nitrogen is usually the main soluble form. Utilisation of proteinaceous organic matter by bacteria in the sea as a source of energy probably causes some liberation of ammonia-nitrogen as a result of oxidation-deamination reactions⁽³⁾.

Under anoxic conditions, the following reactions may occur, i.e. denitrification, commonly defined as the biochemical reduction of NO_3^- or NO_2^- to N_2 or gaseous nitrogen oxides.



Nitrification is defined as the biological oxidation of ammonium to nitrate with nitrite as an intermediate in the reaction sequence. Through these abovementioned processes, ammonia can either be added or removed from the seawater due to the presence of certain bacteria⁽³¹⁾.

AMMONIUM continued on next page



AMMONIUM continued...

**Interdependence
on other constituents**

The relative proportions of NH_3 and NH_4^+ in solutions depend chiefly on temperature and pH and, to a lesser extent, on salinity. Concentrations of NH_3 increase with elevated temperatures and pH values, and decrease with higher salinities ⁽²⁰⁾.

PERCENT UNIONISED AMMONIA (NH_3) IN SEAWATER ($S = 32 \times 10^{-3}$ - 40×10^{-3}) AT DIFFERENT TEMPERATURES AND pHs AT 1 ATM PRESSURE				
Temp	pH			
EC	7,5	8,0	8,5	9,0
10	0,459	1,44	4,41	12,6
15	0,665	2,07	6,28	17,6
20	0,963	2,98	8,87	23,6
25	1,39	4,28	12,4	30,9

At salinities common in seawater (32×10^{-3} - 40×10^{-3}) there is up to one fifth less unionised ammonia (NH_3) than in fresh water at the same temperature and pH.

**Measurement
in seawater**

Total ammonia ($\text{NH}_4 + \text{NH}_3$) can be determined photometrically in seawater ⁽¹⁹⁾.

Units: $\mu\text{g l}^{-1}$ ($\text{NH}_4^+ + \text{NH}_3$) -N or $\mu\text{mol l}^{-1}$ ($\text{NH}_4 + \text{NH}_3$) -N (the latter can be converted to $\mu\text{g l}^{-1}$ [$\text{NH}_4^+ + \text{NH}_3$]-N by multiplying with the atomic mass of N, i.e. 14).

Pollution sources

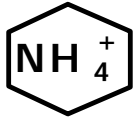
Anthropogenic sources of ammonia include ⁽⁹⁾:

- sewage discharges;
- run-off from agricultural areas, especially where fertilizers are applied;
- septic tank seepage.

Treatability

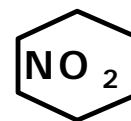
Where seawater is used in enclosed systems, e.g. aquariums, ammonia concentrations can be controlled in the short-term by bubbling with CO_2 , which will reduce the pH of the water and in doing so shift the equilibrium of the $\text{NH}_3/\text{NH}_4^+$ reaction towards the less toxic ionised form.

AMMONIA continued on next page



AMMONIA continued...

Related problems	Typical water quality problems which may be associated with the presence of ammonia/ammonium include: - excessive leaching and loss of salts.	For more details on problems refer to: p 3-4
Effects of change and target values	General effects of different ranges of ammonium on industrial uses (<i>Salt production</i>) could not be obtained. However, the target range for nutrients is provided in Section 5.	Refer to: p 5-7



NITRITE

Description Nitrite occurs in seawater as an intermediate compound in the microbial reduction of nitrate or in the oxidation of ammonia⁽²³⁾:



Natural occurrence Limited information is available on the natural occurrence of nitrite along the South African coast. The following mean nitrite concentrations (NO_2^- -N) have been reported for South African coastal waters⁽²⁴⁾:

WEST COAST	SOUTH COAST	EAST COAST
4,2 $\mu\text{g l}^{-1}$	2,8 $\mu\text{g l}^{-1}$	No data could be obtained

Fate in environment Nitrite may be excreted by phytoplankton, especially during periods of luxury feeding, i.e. when a surplus of nitrate and phosphate stimulates a heavy bloom of plankton⁽²³⁾.

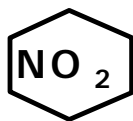
The natural level of nitrite in seawater is usually very low but in transition zones, where oxic conditions change to anoxic ones, thin layers of high nitrite concentrations may occur together with rather low levels of dissolved oxygen⁽²³⁾. In upwelling areas, elevated nitrite values indicate high activity of the primary producers⁽²³⁾.

The natural level of nitrite in seawater is less than 1,4 $\mu\text{g l}^{-1}$ NO_2^- -N. In anoxic zones with low levels of oxygen (less than 0,15 ml l^{-1}), nitrite concentrations in excess of 28 $\mu\text{g l}^{-1}$ NO_2^- -N have been measured. Under upwelling conditions, levels can be between 14 and 28 $\mu\text{g l}^{-1}$ NO_2^- -N⁽²³⁾.

Interdependence on other constituents Low dissolved oxygen concentrations favour the formation of nitrite. Nitrite photolysis gives rise to a 10^4 - fold supersaturation of nitrogen oxide in water with respect to its concentration in the air⁽²⁵⁾.

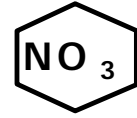
The toxicity of nitrite, while still formidable, is significantly reduced in seawater due to the high concentration of chloride and calcium⁽¹⁵⁾.

NITRITE continued on next page



NITRITE continued...

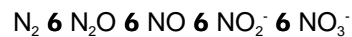
Measurement in seawater	<p>Dissolved nitrite can be determined photometrically in seawater⁽¹⁹⁾.</p> <p>Units: $\mu\text{g l}^{-1} \text{NO}_2^- \text{-N}$ or $\mu\text{mol l}^{-1} \text{NO}_2^- \text{-N}$ (the latter can be converted to $\mu\text{g l}^{-1} \text{NO}_2^- \text{-N}$ by multiplying with the atomic mass of N, i.e. 14).</p>		
Pollution sources	<p>Anthropogenic sources of nitrite include⁽⁹⁾:</p> <ul style="list-style-type: none"> - sewage discharges; - run-off from agricultural areas, especially where fertilizers are applied; - septic tank seepage. 		
Treatability	<p>Practical treatment methods for removing nitrite from seawater could not be obtained.</p>		
Related problems	<table border="0"> <tr> <td data-bbox="480 1099 1193 1272"> <p>Typical water quality problems which may be associated with the presence of nitrite include:</p> <ul style="list-style-type: none"> - excessive leaching and loss of salts. </td> <td data-bbox="1214 1093 1390 1272" style="border-left: 1px solid black; padding-left: 10px;"> <p>For more details on problems refer to:</p> <p>p 3-4</p> </td> </tr> </table>	<p>Typical water quality problems which may be associated with the presence of nitrite include:</p> <ul style="list-style-type: none"> - excessive leaching and loss of salts. 	<p>For more details on problems refer to:</p> <p>p 3-4</p>
<p>Typical water quality problems which may be associated with the presence of nitrite include:</p> <ul style="list-style-type: none"> - excessive leaching and loss of salts. 	<p>For more details on problems refer to:</p> <p>p 3-4</p>		
Effects of change and target values	<table border="0"> <tr> <td data-bbox="480 1346 1193 1525"> <p>General effects of different ranges of nitrite on industrial uses (<i>Salt production</i>) could not be obtained.</p> <p>However, the target range for nutrients is provided in Section 5.</p> </td> <td data-bbox="1214 1346 1390 1525" style="border-left: 1px solid black; padding-left: 10px;"> <p>Refer to:</p> <p>p 5-7</p> </td> </tr> </table>	<p>General effects of different ranges of nitrite on industrial uses (<i>Salt production</i>) could not be obtained.</p> <p>However, the target range for nutrients is provided in Section 5.</p>	<p>Refer to:</p> <p>p 5-7</p>
<p>General effects of different ranges of nitrite on industrial uses (<i>Salt production</i>) could not be obtained.</p> <p>However, the target range for nutrients is provided in Section 5.</p>	<p>Refer to:</p> <p>p 5-7</p>		



NITRATE

Description

Nitrate is the final oxidation product of nitrogen compounds in seawater and is considered to be the only thermodynamically stable oxidation level of nitrogen in the presence of oxygen in seawater⁽²³⁾:



Natural occurrence

Nitrate in oxygenated seawater with a salinity of 35×10^{-3} can range from less than 1,4 to $630 \mu\text{g l}^{-1} \text{NO}_3^- \text{-N}$, with an average concentration of $420 \mu\text{g l}^{-1} \text{NO}_3^- \text{-N}$. Nitrate concentrations usually increase with depth, i.e surface depletion and enrichment at depth. This type of distribution is referred to as a nutrient type distribution⁽²⁵⁾.

West coast. Nutrient supply to the surface water occurs via the upwelling process⁽¹⁸⁾. The supply of nutrients to the euphotic zone by the upwelling process triggers the high biological productivity of the Benguela ecosystem and is the major feature driving the important commercial fish populations that occur in the area. Average nitrate concentrations (as $\text{NO}_3^- \text{-N}$) reported for the west coast⁽²⁴⁾, as well as those specifically reported for upwelled waters are⁽²⁶⁾:

AVERAGE	UPWELLED WATERS
$16,4 \mu\text{g l}^{-1}$	$280 \pm 56 \mu\text{g l}^{-1}$

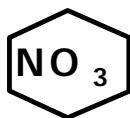
South coast. Along the south coast, coastal upwelling brings water rich in nutrients to the surface. The following average nitrate concentrations ($\text{NO}_3^- \text{-N}$) have been reported for the south coast⁽²⁴⁾:

AVERAGE
$81 \mu\text{g l}^{-1}$

East coast. Waters of tropical origin are generally poor in nutrients resulting in generally low primary productivity. Higher nutrient concentrations are usually associated with upwelling. Average nitrate (as $\text{NO}_3^- \text{-N}$) concentrations such as reported for the east coast are⁽²⁷⁾:

AVERAGE		
PORT EDWARD	DURBAN	RICHARDS BAY
$35 \mu\text{g l}^{-1}$	$47 \mu\text{g l}^{-1}$	$38 \mu\text{g l}^{-1}$

NITRATE continued on next page



NITRATE continued...

Fate in environment

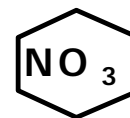
Nitrate, as with phosphate, is a minor constituent and essential nutrient. It is extracted from the surface water by photosynthesising plankton to make organic tissue. Nitrate is totally depleted in surface waters where biological production is high, and is known as a biolimiting constituent. Together with phosphate, it limits production, i.e. when these nutrients are exhausted, production ceases. When the organisms are consumed or when they die and decompose, these nutrients are returned to the water column. Nitrate concentrations usually decrease with depth⁽¹⁴⁾.

In many marine waters, nitrate is considered to be the micronutrient controlling primary production in the euphotic surface layers. The concentration of nitrate in these layers is governed by the advective transport of nitrate into surface layers, the microbial oxidation of ammonia and the uptake by the primary producers. If the light penetration into the water is sufficient, the uptake rate is usually much faster than the processes transporting the nitrate into the surface layers. Therefore, the nitrate concentration in most ocean surface waters is close to zero⁽²³⁾.

In temperate climatic zones, where winter cooling of the surface waters produces deep-reaching vertical mixing, the nitrate content of seawater follows a fairly regular cycle with high values in autumn, winter and early spring and low values in spring and summer. In upwelling areas, the supply rate of nitrate is very often considerably higher than the uptake rate. For this reason, the measurement of the concentration of nitrate can be usefully applied as an indicator for upwelling and, together with temperature measurements, as a means to separate the apparent decrease of micronutrients downstream of an upwelling area by a physical mixing process and biological uptake⁽²³⁾.

Nitrate and phosphate are used to form the soft tissue of organisms and the molar ratio of nitrate to phosphate in ocean water is close to the ratio of 15:1 for organic tissues; thus, when all the dissolved phosphate in surface waters has been used up, so has all the dissolved nitrate. Why nitrate and phosphate should occur in seawater in the same ratio required by organisms remains one of the intriguing mysteries of seawater chemistry⁽¹⁴⁾.

NITRATE continued continued on next page



NITRATE continued...

Interdependence on other constituents If the oxygen content of seawater becomes depleted as a result of microbial remineralisation processes, nitrate may be used as an alternative electron acceptor instead of oxygen. This process, called denitrification, leads to the reduction of a portion of nitrate to molecular nitrogen (N₂). It was found that the reduction of sulphate commences only after the available nitrate has been quantitatively used up. It is, therefore, very unlikely that nitrate may co-exist for any length of time in the presence of hydrogen sulphide. Usually the nitrate reduction zone is separated from waters containing sulphide by a layer in which the nitrate concentration has been reduced to less than 1,4 µg l⁻¹ NO₃⁻-N and where oxygen values are below 0,02 ml l⁻¹. The presence of nitrate in sulphide containing water indicates turbulent mixing processes between anoxic water and the water from the transition layer, or it may be the result of analytical errors⁽²³⁾.

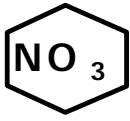
Measurement in seawater Dissolved nitrate can be determined photometrically in seawater⁽¹⁹⁾.
Units: µg l⁻¹ NO₃⁻-N or µmol l⁻¹ NO₃⁻-N (the latter can be converted to µg l⁻¹ NO₃⁻-N by multiplying with the atomic mass of N, i.e. 14).

Pollution sources Anthropogenic sources of nitrate include⁽⁹⁾:

- sewage discharges;
- run-off from agricultural areas, especially where fertilizers are applied;
- septic tank seepage.

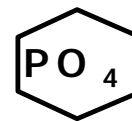
Treatability Practical treatment methods for removing nitrate from seawater could not be obtained.

NITRATE continued on next page



NITRATE continued...

Related problems	Typical water quality problems which may be associated with the presence of nitrate include: - excessive leaching and loss of salts.	For more details on problems refer to: p 3-4
Effects of change and target values	General effects of different ranges of nitrate on industrial uses (<i>Salt production</i>) could not be obtained. However, the target range for nutrients is provided in Section 5.	Refer to: p 5-7



REACTIVE PHOSPHATE

Description

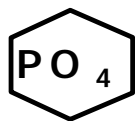
Phosphorus is an abundant element, with reactive phosphate being one of the most important nutrients. Phosphorus is normally found in the sea in the form of soluble inorganic phosphorus, i.e. reactive phosphate, particulate and organic forms. During weathering, solutions containing alkali phosphates and dissolved or colloidal calcium phosphate are carried to the sea⁽²³⁾.

A variety of organic phosphorus compounds are present in the upper layers of the sea. These compounds are decomposition and excretion products of organisms and, therefore, phospholipid, phospho-nucleotides and their derivatives may be found in seawater. Sugar phosphates and amino-phosphoric acids most probably exist⁽²³⁾.

Probable main species in oxygenated seawater are HPO_4^{2-} , NaHPO_4^- and MgHPO_4^0 ⁽²⁵⁾. Other sources state that 1 % of the orthophosphate is present as H_2PO_4^- , 87 % as HPO_4^{2-} and 12 % as PO_4^{3-} , also that 96 % of the PO_4^{3-} and 44 % of the HPO_4^{2-} are apparently present in seawater as ion pairs, probably with calcium and magnesium. Maybe because of this fact, calcium phosphate is more soluble in seawater than in distilled water (ion pair and complex formation)⁽³⁾.

Nitrate and phosphate are used to form the soft tissue of organisms and the molar ratio of nitrate to phosphate in ocean water is close to the ratio of 15:1 for organic tissues; thus, when all the dissolved phosphate in surface waters has been used up, so has all the dissolved nitrate. This ratio remains one of the intriguing mysteries of seawater chemistry⁽¹⁴⁾.

REACTIVE PHOSPHATE continued on next page



REACTIVE PHOSPHATE continued...

Natural occurrence

The mean concentration of reactive phosphate in seawater has been estimated to be about $62 \mu\text{g l}^{-1} \text{PO}_4^{3-}\text{-P}$ ⁽²³⁾. Another source ⁽²⁵⁾ reported reactive phosphate in seawater with a salinity of 35×10^{-3} , to range between less than 31 to $109 \mu\text{g l}^{-1} \text{PO}_4^{3-}\text{-P}$, with an average concentration of $71 \mu\text{g l}^{-1} \text{PO}_4^{3-}\text{-P}$. This distribution is called a nutrient type distribution ⁽²⁵⁾.

West coast. Nutrient supply to the surface water occurs via the upwelling process ⁽¹⁸⁾. Average total phosphorus concentrations (as P) reported for the west coast ⁽²⁴⁾, as well as those specifically reported for upwelled waters (as $\text{PO}_4^{3-}\text{-P}$) are ⁽²⁶⁾:

AVERAGE	UPWELLED WATERS
$53 \mu\text{g l}^{-1}$	$47 \pm 1,6 \mu\text{g l}^{-1}$

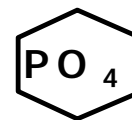
South coast. Along the south coast, coastal upwelling brings water rich in nutrients to the surface. The following average concentration for total phosphorus (as P) has been reported for the south coast ⁽²⁴⁾:

AVERAGE
$37 \mu\text{g l}^{-1}$

East coast. Waters of tropical origin are generally poor in nutrients resulting in generally low primary productivity. Higher nutrient concentrations are usually associated with upwelling. Average phosphate (as $\text{PO}_4^{3-}\text{-P}$) concentrations reported for the east coast are ⁽²⁷⁾:

AVERAGE		
PORT EDWARD	DURBAN	RICHARDS BAY
$19 \mu\text{g l}^{-1}$	$19 \mu\text{g l}^{-1}$	$24 \mu\text{g l}^{-1}$

REACTIVE PHOSPHATE continued on next page



 REACTIVE PHOSPHATE continued...

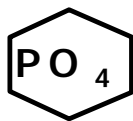
Fate in environment The enigma of the sea is that all the sunlight is at the top and most of the phosphate at the bottom. The phosphate concentration at the surface is low because of the steady down drift of organic debris. This is because phytoplankton only lives in the photic zone. They are consumed by zooplankton and other animals that package most of their waste products into faecal pellets. Only about 1% of this organic matter actually reaches the sediments. Because of the enormous pressures in the sea most of this debris is crushed and its phosphate released before it reaches the bottom⁽²⁸⁾.

The phosphate concentration increases with depth, showing a nutrient type distribution⁽¹⁴⁾. Upwelling conditions can introduce phosphates to surface waters, while anoxic conditions will facilitate the return of phosphate from the sediment back into solution. Phosphate which is held in sediment as insoluble $\text{Fe}_3(\text{PO}_4)_2$, and insoluble CaH_2PO_4 will be acidified to soluble $\text{Ca}(\text{H}_2\text{PO}_4)_2$ ⁽²⁸⁾.

Interdependence on other constituents Precipitated inorganic phosphorus in sediments can resolubilise in anoxic conditions, i.e. under low *pH* and low *dissolved oxygen* levels⁽²⁸⁾.

Measurement in seawater Dissolved reactive phosphate can be determined photometrically in seawater⁽¹⁹⁾.
Units: $\mu\text{g l}^{-1} \text{PO}_4^{3-} - \text{P}$ or $\mu\text{mol l}^{-1} \text{PO}_4^{3-} - \text{P}$ (the latter can be converted to $\mu\text{g l}^{-1} \text{PO}_4^{3-} - \text{P}$. by multiplying with the atomic mass of P, i.e. 31).

REACTIVE PHOSPHATE continued on next page



REACTIVE PHOSPHATE *continued...*

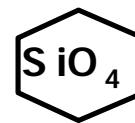
Pollution sources Anthropogenic sources of phosphate include⁽⁹⁾:

- waste products from manufacturing phosphoric acid for fertilizer production;
- phosphatisation of metals in plating and metal processing industries;
- sewage discharges (including household detergents);
- agricultural run-off (over fertilization with super-phosphates is a common problem and enormous amounts are brought to the sea by rivers in some areas⁽²³⁾;
- run-off from dairy farms and piggeries.

Treatability Practical treatment methods for removing phosphate from seawater could not be obtained.

Related problems	Typical water quality problems which may be associated with the presence of reactive phosphate include:	For more details on problems refer to:
	- excessive leaching and loss of salts.	p 3-4

Effects of change and target values	General effects of different ranges of reactive phosphate on industrial uses (<i>Salt production</i>) could not be obtained.	Refer to:
	However, the target range for nutrients is provided in Section 5.	p 5-7



REACTIVE SILICATE

Description

During weathering of silicate material, silicon is brought into ionic solution, probably in the form of alkali salts of the orthosilicic acid, $\text{Si}(\text{OH})_4$. High concentrations of silicon are found dissolved in rivers emanating from volcanic sources. It has been estimated that the total annual river output to oceans is about 200 million tons of dissolved silicon with over double this amount added by glacial weathering of rocks in Antarctica⁽²³⁾.

About half of the suspended matter in seawater is of inorganic origin and this part contains a large proportion of silicon identified in clays and other minerals. In surface waters, the concentration of suspended silicon generally exceeds that in solution, but at depths greater than about 100 m, it represents only a few percent of the total⁽²³⁾.

Silicon probably existing as hydrated silica, is a major constituent of diatoms, which form a large proportion of marine phytoplankton. Some fungi and siliceous sponges also have structural parts containing silica. The diatoms and radiolaria can also excrete silica in the form of opal, amorphous hydrated silica ($\text{SiO}_2 \cdot n\text{H}_2\text{O}$). When siliceous organisms die, silica is liberated into the seawater⁽²³⁾.

Natural occurrence

Seawater is quite undersaturated with respect to the element, since the solubility of silicate is around 50 mg l^{-1} (as Si)⁽²³⁾.

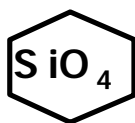
The silicon in solution in seawater is probably in the form of ortho silicic acid H_4SiO_4 ⁽²⁵⁾.

The concentrations in surface waters to deep waters range from less than 28 to $5\,040 \text{ ug l}^{-1}$ (as Si), with an average concentration of $2\,800 \text{ ug l}^{-1}$. This distribution is called a nutrient type distribution⁽²⁵⁾.

West coast. Nutrient supply to the surface water occurs via the upwelling process⁽¹⁸⁾. Average reactive silicate concentrations (as Si) reported for the west coast⁽²⁴⁾, as well as those specifically reported for upwelled waters are⁽²⁶⁾:

AVERAGE	UPWELLED WATERS
$381 \text{ } \mu\text{g l}^{-1}$	$420 \pm 140 \text{ } \mu\text{g l}^{-1}$

REACTIVE SILICATE continued on next page



REACTIVE SILICATE *continued...*

Natural occurrence
continued...

South coast. Along the south coast, coastal upwelling brings water rich in nutrients to the surface. The following mean reactive silicate concentrations (as Si) have been reported for the south coast⁽²⁴⁾:

AVERAGE
146 µg l⁻¹

East coast. Waters of tropical origin are generally poor in nutrients resulting in generally low primary productivity. Higher nutrient concentrations are usually associated with upwelling. Average reactive silicate (as Si) concentrations reported for the east coast are⁽²⁷⁾:

AVERAGE		
PORT EDWARD	DURBAN	RICHARDS BAY
83 µg l⁻¹	104 µg l⁻¹	97 µg l⁻¹

Fate in environment

Silica is a biolimiting nutrient, but is used only to make the hard parts of some planktonic organisms (diatoms, radiolarians). The skeletal remains dissolve slowly as they sink into deep water after death, and accumulate in sediments on the sea floor. Because it is a biolimiting nutrient whose availability in surface waters limits biological production, its characteristic vertical profiles show almost total depletion in surface waters because they are controlled principally by biological processes⁽¹⁴⁾.

Interdependence on other constituents

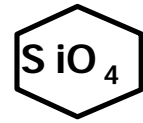
The solubility of silica decreases as the temperature decreases. The solubility of amorphous opaline silica decreases by about 30 % for a drop in temperature from 25 to 5°C. In deep oceans, because of high pressure the solubility increases slightly^(14,29).

Measurement in seawater

Dissolved reactive silicate can be determined photometrically in seawater⁽¹⁹⁾.

Units: µg l⁻¹ SiO₄²⁻-Si or µmol l⁻¹ SiO₄²⁻-Si (the latter can be converted to µg l⁻¹ SiO₄²⁻-Si by multiplying with the atomic mass of Si, i.e. 28).

REACTIVE SILICATE *continued on next page*



REACTIVE SILICATE continued...

Pollution sources Anthropogenic sources of silicate are not clearly defined.

Treatability Practical treatment methods for removing silicates from seawater could not be obtained.

Related problems	Typical water quality problems which may be associated with the presence of reactive silicate include: - excessive leaching and loss of salts.	For more details on problems refer to: p 3-4
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Effects of change and target values	General effects of different ranges of reactive silicate on industrial uses (<i>Salt production</i>) could not be obtained. However, the target range for nutrients is provided in Section 5.	Refer to: p 5-7
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Chapter 4.3 Inorganic Constituents

HYDROGEN SULPHIDE

Description Hydrogen sulphide is a poisonous gas which readily dissolves in water. No heterotrophic life can exist in water containing hydrogen sulphide, and such affected areas are therefore transformed into oceanic 'deserts'⁽²³⁾.

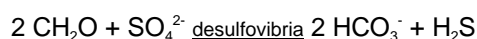
The speciation of H₂S in seawater at 25 °C, a pH of 8,1 and a salinity of 35x10⁻³ is H₂S (3,07 %), HS⁻ (96,93 %) and S²⁻ (1,9 x 10⁻⁴ %) ⁽²¹⁾.

Natural occurrence Hydrogen sulphide is a frequent component of anoxic waters, attaining concentrations as high as 70 mg l⁻¹ under extreme conditions ⁽²⁸⁾.

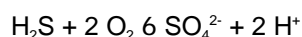
Fate in environment Dissolved oxygen in seawater is utilised by bacteria for oxidising organic matter to carbon dioxide, water and inorganic ions. In deep water of stagnant basins and in sea areas with a very slow water exchange or a high load of organic matter, all the dissolved oxygen may be utilised, leading to anoxic conditions ⁽¹⁶⁾.

Hydrogen sulphide behaves as a weak acid, and is present in natural waters as both the undissociated compound and the HS⁻ ion (below pH 12 the concentration of S²⁻ ion is negligible). Hydrogen sulphide is very volatile and reacts rapidly with oxygen ⁽¹⁶⁾.

Hydrogen sulphide is produced in anaerobic environments by the activities of sulphate-reducing bacteria, which derive energy from a process of anaerobic respiration.

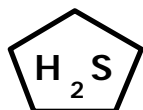


Probably only a small fraction of H₂S is released into the atmosphere. In many environments, it reacts instead with iron to form insoluble iron sulphide, an abundant constituent of anaerobic organic rich sediments. Much of the sulphide that is not immobilised in this fashion is oxidised by bacteria that derives energy from the following reaction as soon as it reaches the aerobic level of the water profile ⁽²⁸⁾:



Therefore H₂S is slowly oxidised to sulphate in seawater. Evidence of this is that molecular sulphur does not accumulate in sediments in natural stagnant sea basins e.g. the Black Sea ⁽²⁸⁾.

HYDROGEN SULPHIDE continued on next page



HYDROGEN SULPHIDE continued...

Interdependence on other constituents

The solubility of hydrogen sulphide decreases with increasing temperature and salinity, e.g. the solubility of H₂S in acidified seawater (pH 2,8 - 3,0) expressed as mg l⁻¹ at 1 atm pressure⁽²²⁾:

TEMPERATURE (°C)	SALINITY		
	30x10 ⁻³	35x10 ⁻³	40x10 ⁻³
0	6 730,8	6 672,9	6 611,5
10	4 975,7	4 945,0	4 910,9
15	4 338,4	4 314,5	4 287,3
20	3 817,0	3 796,5	3 776,1
25	3 380,7	3 367,1	3 350,1
30	3 019,5	3 005,9	2 992,2

In contact with oxygen, hydrogen sulphide is *rapidly* oxidised to sulphur in an *acid* medium, but *slowly* to sulphate in more neutral solutions like seawater⁽²³⁾.

Also refer to *Fate in the Environment* on p 4-29.

Measurement in seawater

Hydrogen sulphide in seawater can be analysed photometrically or titrimetrically. The photometric method is more sensitive and accurate⁽¹⁹⁾.

Pollution sources

Although hydrogen sulphide is usually not directly introduced to the marine environment through anthropogenic sources, those with high oxygen demand (reflected in high organic content, high biochemical oxygen demand or chemical oxygen demand) can favour conditions for the formation of hydrogen sulphide.

Treatability

Where seawater is used in enclosed systems, e.g. aquariums, aeration is probably the most practical way to reduce hydrogen sulphide levels.

HYDROGEN SULPHIDE continued on next page



HYDROGEN SULPHIDE continued...

Related problems

Typical water quality problems which may be associated with the hydrogen sulphide include:

- unpleasant aesthetics.

For more details on problems refer to:

p 3-7

Effects of change and target values

No factual information on effects of different ranges of hydrogen sulphide on industrial uses could be obtained.

No target values for hydrogen sulphide have been selected for the South African coastal zone.



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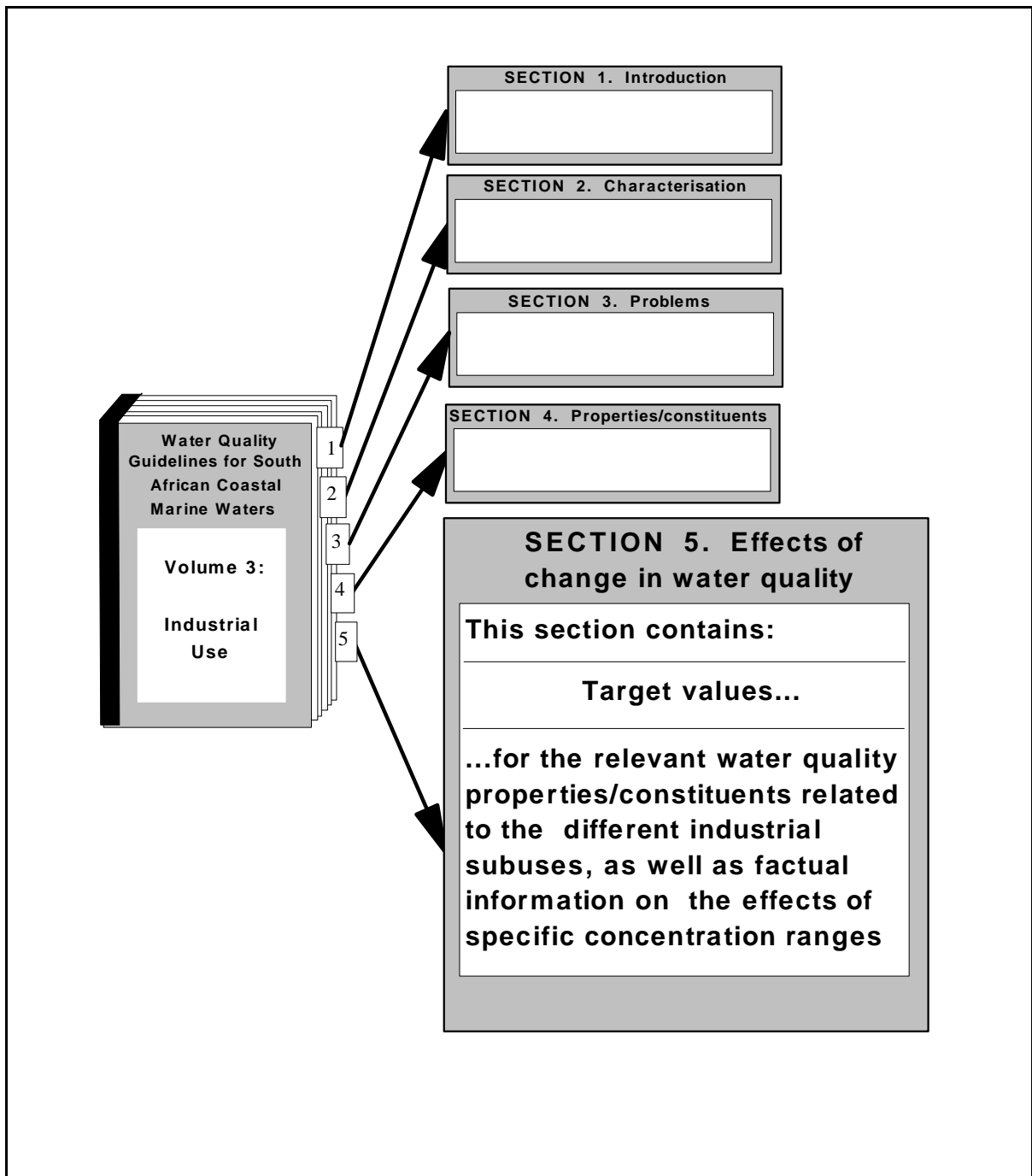
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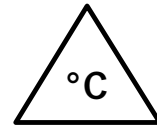
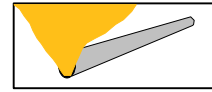
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SECTION 5: EFFECTS OF CHANGE IN WATER QUALITY RELATED TO INDUSTRIAL USE (INCLUDING TARGET VALUES)



SECTION 5: EFFECTS OF CHANGE CONTENTS

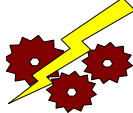
Chapter 5.1	Physico-chemical Properties	5-1
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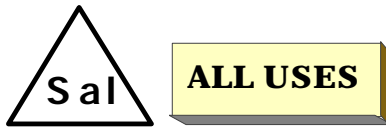


Chapter 5.1 Physico-chemical Properties

TEMPERATURE (Refer to p 4-1)

Make-up water for marine outfalls
 (Refer to p 2-47)

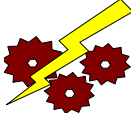
TEMPERATURE (°C)	 Mechanical/Process Interferences
Target value for the South African coastal zone: The maximum acceptable variation in ambient temperature is + or - 1 °C⁽¹⁾	
< 25	There was no negative impact on the functioning of pumps when using seawater as make-up water in marine outfall systems (Mhlathuze Water, Richards Bay)
> 27	Because seawater is also used to cool the effluent in certain instances, these higher temperatures affect the nett positive suction of pumps and thus reduce the capacity of the pumps (Mhlathuze Water, Richards Bay)



SALINITY (Refer to p 4-3)

All Industrial Uses

(Refer to Section 2)

SALINITY	 Mechanical/Process Interferences
No target value has been selected for the South African coastal zone regarding industrial uses ⁽¹⁾	
Natural salinity of seawater (about 35×10^{-3}) (Refer to p 4-3)	Corrosion of metal equipment will occur, unless it is protected against corrosion. Because this effect is anticipated in the industrial uses of seawater, it is generally adequately controlled by using suitable materials and by implementing proper maintenance programmes.

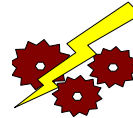
ALL USES



FLOATING MATTER (Refer to p 4-6)

All Industrial Uses

(Refer to Section 2)



TYPE	Mechanical/Process Interferences
<p>Target for the South African coastal zone ⁽¹⁾:</p> <ul style="list-style-type: none"> - Water should not contain floating particulate matter, debris, oil, grease, wax, scum, foam or any similar floating materials and residues from land-based sources in concentrations that may cause nuisance; - Water should not contain materials from non-natural land-based sources which will settle to form putrescence; - Water should not contain submerged objects and other subsurface hazards which arise from non-natural origins and which would be a danger, cause nuisance or interfere with any designated/recognized use 	
<p>Debris, kelp, litter, dead fish, oil and grease films, discarded ropes, discarded fish nets, etc.</p>	<p>Although seawater intake systems are usually capable of removing moderate amounts of floating matter, large quantities may cause blockages or clogging of filters, screens, pipe, pumps, spraying nozzles, ship engines, propellers, etc. This disrupts the industrial process and may increase treatment costs such as the cleaning costs of filters and removal and dumping costs of matter. Where an increase in floating matter is anticipated, for example, a major fish kill after red tides along the west coast, seawater intake is stopped (salt production and seafood processing factories). Although this action prevents additional treatment costs, it may disrupt the industrial process.</p> <p>In certain instances, contingency plans (deployment of booms) are in place to prevent the intake of oil in the case of accidental spills (cooling water system at Koeberg nuclear power station).</p> <p>Surface abstraction of ballast water must be avoided to eliminate floating objects.</p> <p>In most instances, the effect is temporary and systems usually function normally once the intake of floating matter can be reduced, unless the floating object caused physical damage, in which case the equipment will have to be repaired/replaced.</p>

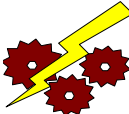
NOTE: For the use of seawater as make-up water for marine outfalls, floating matter should be less than 5-10 mm in diameter to prevent blockages (Mhlathuze Water, Richards Bay)



SUSPENDED SOLIDS (Refer to p 4-7)

All Industrial Uses

(Refer to Section 2)

SUSPENDED SOLIDS	 <p>Mechanical/Process Interferences</p>
<p>Target range for the South African coastal zone: The concentration of suspended solids should not be increased by more than 10 % of the ambient concentration ⁽¹⁾</p>	
	<p>Although it could not be quantified, the presence of suspended solids may result in clogging and blockage of equipment such as pipes, screens engines, etc.</p>

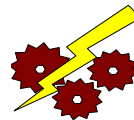
NOTE: For the use of seawater as make-up water for marine outfalls, suspended solids should be less than 5-10 mm in diameter to prevent blockages (Mhlathuze Water, Richards Bay)

ALL USES

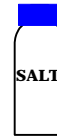


COLOUR/TURBIDITY/CLARITY (Refer to p 4-9)

All Industrial Uses
 (Refer to Section 2)



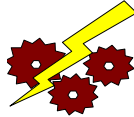
COLOUR/TURBIDITY/ CLARITY	Mechanical/Process Interferences
<p>Target for the South African coastal zone ⁽¹⁾:</p> <p><i>Turbidity and colour</i> acting singly or in combination should not reduce the depth of the euphotic zone by more than 10 % of background levels measured at a comparable control site.</p> <p>The <i>colour</i> (substances in solution) of water should not exceed background levels by more than 35 Hazen units.</p>	
	<p>Although it could not be quantified, the presence of turbidity may result in clogging and blockage of equipment such as pipes, screens engines, etc.</p>

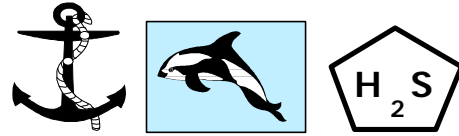


Chapter 5.2 Nutrients

ALL NUTRIENTS (Refer to p 4-11 to p 4-25)

Salt Production
 (Refer to p 2-13)


NUTRIENT LEVELS	 Mechanical/Process Interferences
Target for the South African coastal zone: Waters should not contain concentrations of dissolved nutrients that are capable of causing excessive or nuisance growth of algae or other aquatic plants, or reducing dissolved oxygen concentrations below the target range indicated for <i>dissolved oxygen</i> ⁽¹⁾	
Above natural concentrations (Refer to p 4-11 to p 4-25)	<p>The natural balance in the growth of bacteria and organisms that seal the solar ponds can be upset, resulting in excessive leaching and loss of salts from the ponds.</p> <p>The natural sealing of the ponds will re-establish itself when seawater with natural nutrients levels is again introduced in the ponds, although this may take some time.</p>



Chapter 5.3 Inorganic Constituents

HYDROGEN SULPHIDE (Refer to p 4-29)

**Aquariums and oceanariums,
 Harbours and ports**
 (Refer to p 2-23 and p 2-31)

HYDROGEN SULPHIDE	 Aesthetics
No target value has been set for the South African coastal zone ⁽¹⁾	
	Although it could not be quantified, the presence of hydrogen sulphide can cause unpleasant odours



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APPENDICES

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B. International Target Values for Industrial Use	B-1
C. Glossary of Terms	C-1
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APPENDIX A: SUMMARY OF TARGET VALUES FOR INDUSTRIAL USE OF SEAWATER

Physico-chemical properties

	MAKE-UP WATER FOR MARINE OUTFALLS	OTHER INDUSTRIAL USES
Temperature	The maximum acceptable variation in ambient temperature is + or - 1 °C	-
Salinity	-	
pH	-	
Floating matter, including oil and grease	<p>Water should not contain floating particulate matter, debris, oil, grease, wax, scum, foam or any similar floating materials and residues from land-based sources in concentrations that may cause nuisance;</p> <p>Water should not contain materials from non-natural land-based sources which will settle to form putrescence;</p> <p>Water should not contain submerged objects and other subsurface hazards which arise from non-natural origins and which would be a danger, cause nuisance or interfere with any designated/recognized use</p>	
Colour/turbidity/ clarity	<p>Should not be more than 35 <i>Hazen units</i> above ambient concentrations (colour)</p> <p>Should not reduce the depth of the euphotic zone by more than 10 % of ambient levels measured at a suitable control site (turbidity)</p>	
Suspended solids	Should not be increased by more than 10 % of ambient concentrations	
Dissolved oxygen	-	

SUMMARY OF TARGET VALUES continued on next page

Target values

SUMMARY OF TARGET VALUES *continued...*

Nutrients

	SALT PRODUCTION	OTHER INDUSTRIAL USES
Ammonium	Waters should not contain concentrations of dissolved nutrients that are capable of causing excessive or nuisance growth of algae or other aquatic plants or reducing dissolved oxygen concentrations below the target range indicated for <i>Dissolved oxygen</i> (see p A-1)	-
Nitrite		-
Nitrate		-
Reactive phosphate		-
Reactive silicate		-

Inorganic constituents

	ALL INDUSTRIAL USES
Ammonia	-
Cyanide	-
Fluoride	-
Chlorine	-
Hydrogen sulphide	-
Arsenic	-
Cadmium	-
Chromium	-
Copper	-
Lead	-
Mercury	-
Nickel	-
Silver	-
Tin	-
Zinc	-

SUMMARY OF TARGET VALUES *continued on next page*

Target values**SUMMARY OF TARGET VALUES continued...**

Organic constituents

	ALL INDUSTRIAL USES
Organotins (Tributyltin)	-
Total petroleum hydrocarbons	-
Polycyclic aromatic hydrocarbons	-

Microbiological indicator organisms

	ALL INDUSTRIAL USES
Faecal coliforms (including <i>E. coli</i>)	-

APPENDIX B: INTERNATIONAL TARGET VALUES FOR INDUSTRIAL USE OF SEAWATER

NOTE: Target values for the typical industrial uses of fresh water are available. However, target values specifically related to the use of seawater in industrial processes were not readily available. Where available, target values that could possibly also be applied to marine waters have been listed below.

Physico-chemical properties

	CANADA ¹	US-EPA ²	EEC (afterUK) ³	AUSTRALIA ⁴
Temperature		-	-	-
Salinity		-	-	-
pH	6,0-8,3 (cooling and make-up water) 6,5-8,5 (food canning and processing)	-	-	6,0-8,3 (cooling and make-up water) 6,5-8,5 (food canning and processing)
Floating matter, including oil and grease	No floating oil (cooling and make-up water)	-	-	No floating oil (cooling and make-up water)
Colour/turbidity/ clarity	5 NTU (food canning) 1-10 NTU (food processing)	-	-	5 NTU (food canning) 1-10 NTU (food processing) 15 Pt-Co (food processing)
Suspended solids	2 500 mg l ⁻¹ (cooling and make-up water) 10 mg l ⁻¹ (food canning)	-	-	2 500 mg l ⁻¹ (cooling and make-up water) 10 mg l ⁻¹ (food canning)
Dissolved oxygen	(COD should be less than 75 mg l ⁻¹ - cooling and make-up water)	-	-	(COD should be less than 75 mg l ⁻¹ - cooling and make-up water) > 6,5 mg l ⁻¹ or > 80 % saturation (food processing)

INTERNATIONAL TARGET VALUES continued on next page

International

INTERNATIONAL TARGET VALUES continued...

Nutrients

	CANADA ¹	US- EPA ²	EEC (after UK) ³	AUSTRALIA ⁴
General	-	-	-	-
Nitrite	Not detected (food canning)	-	-	Not detected (food canning) 1 mg l ⁻¹ (food processing)
Nitrate	10 mg l ⁻¹ (food canning)	-	-	10 mg l ⁻¹ (food canning and processing)
Phosphate	-	-	-	-
Total phosphorous	-	-	-	-
Silicate	25 mg l ⁻¹ (cooling and make-up water) 50 mg l ⁻¹ (food canning)	-	-	25 mg l ⁻¹ (cooling and make-up water) 50 mg l ⁻¹ (food canning)

INTERNATIONAL TARGET VALUES continued on next page

International

INTERNATIONAL TARGET VALUES continued...

Inorganic Constituents

	CANADA ¹	US-EPA ²	EEC (after UK) ³	AUSTRALIA ⁴
Ammonia	0,5 mg l ⁻¹ (as NH ₄ -N for food canning)	-	-	0,5 mg l ⁻¹ (as NH ₄ -N for food canning) 0,01 mg l ⁻¹ (as NH ₃ -N for food processing)
Cyanide	-	-	-	0,1 mg l ⁻¹ (food processing)
Fluoride	1 mg l ⁻¹ (food canning and processing)	-	-	1 mg l ⁻¹ (food canning and processing)
Chlorine	-	-	-	-
Hydrogen sulphide	-	-	-	0,05 mg l ⁻¹ (as S ⁻ for food processing)
Gypsum	-	-	-	-
Arsenic	-	-	-	0,05 mg l ⁻¹ (food processing)
Cadmium	-	-	-	0,005 mg l ⁻¹ (food processing)
Chromium	-	-	-	0,05 mg l ⁻¹ (food processing)
Copper	-	-	-	1 mg l ⁻¹ (food processing)
Iron	0,2 mg l ⁻¹ (food canning and processing)	-	-	0,2 mg l ⁻¹ (food canning and processing)
Lead	-	-	-	0,05 mg l ⁻¹ (food processing)
Manganese	0,2 mg l ⁻¹ (food canning and processing)	-	-	0,2 mg l ⁻¹ (food canning and processing)
Mercury	-	-	-	0,001 mg l ⁻¹ (food processing)
Nickel	-	-	-	0,1 mg l ⁻¹ (food processing)
Silver	-	-	-	0,05 mg l ⁻¹ (food processing)
Tin (inorganic)	-	-	-	-
Vanadium	-	-	-	-
Zinc	-	-	-	5 mg l ⁻¹ (food processing)

INTERNATIONAL GUIDELINES continued on next page

International

INTERNATIONAL TARGET VALUES continued...

Organic constituents

	CANADA ¹	US-EPA ²	EEC (after UK) ³	AUSTRALIA ⁴
Organotins (Tributyltin)	-	-	-	-
Total petroleum hydrocarbons	-	-	-	Refer to reference No. 4
Polycyclic aromatic hydrocarbons	-	-	-	Refer to reference No. 4
Algal toxins	-	-	-	-
Tainting substances	Water should be free of objectionable tastes	-	-	Refer to reference No. 4
Other organics	Refer to reference No. 1	-	-	Refer to reference No. 4

INTERNATIONAL TARGET VALUES continued on next page

International

INTERNATIONAL TARGET VALUES continued...

Microbiological indicator organisms and pathogens

	CANADA ¹	US-EPA ²	UK ³	AUSTRALIA ⁴
Total coliform	Should be of approved bacteriological quality (food processing)	-		10 per 100 ml (in 95% of samples throughout any year)
Faecal coliform		-		0 per 100 ml (food processing)
<i>E. coli</i>		-	-	-
Enterococci (faecal streptococci)				-
<i>Salmonella</i>		-		-
Enteroviruses		-		-
Protozoa		-		-

International

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APPENDIX C: GLOSSARY OF TERMS

Abalone	Perlemoen.
Abiotic	The non-living component of an ecosystem.
Absorption	Penetration or uptake of one substance into the body of another (chemical terms).
Adiponitrile	An intermediate in the manufacture of nylon.
Adsorption	Attachment of molecules or ions to a substrate by manipulation of electrical charge or pH.
Adsorbed	see Adsorption.
Aerobic	Where oxygen is available or where molecular oxygen is required for respiration.
Algicidal dose	Amount of a chemical required to kill algae.
Alginate	One of a class of salts of algin, such as sodium alginate.
Aliphatic	Refers to an organic compound of hydrogen and carbon characterised by a straight chain of carbon atoms.
Amperometric titration	A titration involved in measuring an electric current or changes in current during the cause of the titration.
Amphipod	Invertebrates belonging to the order Crustaceans.
Anoxic	Limited or no oxygen availability.
Anaerobic	Where insufficient oxygen is available or where molecular oxygen is not required for respiration.
Anthropogenic	External, e.g. storm water is an anthropogenic source of pollution to the sea.
Atomic spectrophotometry	A method of measuring concentration of substances, usually trace metals, by measuring spectra arising from either emission or absorption of electromagnetic radiation by atoms
Autolyse	(Autolysis) Return of a substance to solution as of phosphate removed from seawater by plankton and returned when these organisms die and decay (path).
Bacteria	Extremely small, relatively simple prokaryotic microorganisms.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS *continued...*

Balanoid zone (upper)	One of four distinct zones recognised on most rocky beaches, high on the shore above the lower Balanoid zone. Limpets and barnacles are characteristic of this zone.
Balanoid zone (lower)	One of four distinct zones recognised on rocky shores, just above the infratidal (subtidal) zone. Algae dominate in this zone.
Barnacle	The common name for a number of species of crustaceans.
Bathymetric	(Bathymetry) The science of measuring ocean depth in order to determine the sea floor topography.
Benthic	Inhabiting the bottom of a water body.
Bioassay	A method for quantitatively determining the concentration of a substance by its effect on a suitable organism or plant under controlled conditions.
Biochemical oxygen demand (BOD)	The amount of dissolved oxygen required to meet the metabolic needs of aerobic organisms in water rich in organic matter.
Biolimiting nutrient	A nutrient whose availability in surface waters limit biological production when not available in sufficient concentrations.
Biomass	The dry weight of living matter, including stored food, present in a species population and expressed in terms of a given area or volume of habitat.
Biotic	Pertaining to life or living organisms and/or induced by actions of living organisms.
Broodstock	Animals used for breeding purposes.
Byssogenesis	The generation of the tuft of strong filaments by which bivalve molluscs are attached to the substratum.
Buffering capacity	A measure of the relative sensitivity of a solution to pH changes on addition of acids or bases.
Carnivorous	Eating flesh (animals).
Chaetognanth	(Chaetognatha) A phylum of abundant arrow worms.
Chemical oxygen demand (COD)	It is the amount of dissolved oxygen required to oxidise all organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant.
Chemolitho-autotroph	A type of bacteria that derives its energy from the assimilation of carbon dioxide from the oxidation of ammonia, sulphur compounds, iron compounds, methane and hydrogen.

GLOSSARY OF TERMS continued on next page

Glossary**GLOSSARY OF TERMS** *continued...*

Cephalopod	(Cephalopoda) Exclusively marine organisms constituting the most advanced class of mollusca, including squids, octopuses and Nautilus.
Chlorophyll a	Refers to the green pigment in plants and algae which is fundamentally part of the process of photosynthesis. Chlorophyll is used as a measure of the amount of algae (phytoplankton) in water.
Chromatographic	Preferential absorption of chemical compounds (gases or liquids) in an ascending molecular weight sequence onto a solid adsorbent material, such as activated carbon, silica gel or alumina.
Ciliate	(Ciliata) Refer to the single class of protozoan subphylum Ciliophora.
Clarity	Refers to the depth to which light can penetrate in a water body.
Coastal zone	For the purpose of these documents, it refers to coastal marine waters.
Cochlear zone	A zone found on the south coast on rocky shores between the infratidal (subtidal) and lower Balanoid zone. It is named after the limpet <i>Patella cochlear</i> that forms a dense band at the low-tide mark.
Coelenterate	(Coelenterata). A phylum of the Radiata whose members typically bears tentacles and possess intrinsic nematocysts.
Colloidal suspension	A mixture of two substances, one of which, called the dispersed phase (or colloid), is uniformly distributed in a finely divided state through the second substance, called the dispersion medium (or dispersing medium). Both phases may be a gas, liquid or solid.
Continental shelf	The zone around a continent, extending from the shoreline to the continental slope.
Continuous flow bioassay	A bioassay where the test organisms are kept in a flow-through system where the water has a particular concentration of the substance/s to be tested for.
Copepod/s	(Copepoda). An order of crustaceans, containing free-living, parasitic and symbiotic forms.
Coriolis force	A velocity-dependent pseudo force in a reference frame which rotates with respect to an inertial reference frame. It is equal and opposite to the product of the mass of the particle on which the force acts and its Coriolis acceleration.
Crustaceans	Animals having joint feet and mandibles, two pairs of antennae and segmented, chitin-encased bodies, including lobster and prawns.
Cyst	A normal or pathogenic sac with a distinct wall, containing fluid or other material.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Demersal fish	Fish living near or at the bottom of the sea.
Depuration rate	Rate at which bivalves loose accumulated substances.
Desorption	Detachment of molecules or ions from a substrate by manipulation of electrical charge or pH.
Detritivore	Any animal that feeds on loose organic material (detritus) removed directly from the water or that collects on the substratum at the bottom of the sea.
Diarrhetic shellfish poison	Algal toxin causing gastrointestinal problems.
Diatoms	The common name for a group of micro-algae, noted for their symmetry and sculpturing of siliceous cell walls.
Dinoflagellate	An order of flagellate protozoan, most members having fixed shapes determined by thick covering plates.
EC	Electrical conductivity.
EC₅₀	Effective concentration where 50% of the test organisms die.
Ecosystem	A functional system which includes the organisms of a natural community together with their abiotic environment.
EEC	European Economic Community.
El Nino	A warm current setting south along the coast of Peru generally developing during February to March concurrently with a southerly shift in the tropical rain belt.
Ephemeral	Carries water only during or immediately after rainfall or snow melt.
Epidemiological	(Epidemiology) The study or science of diseases in a community.
Epiphytes	Plants which grow non-parasitically on another plant or on some non-living structure, deriving moisture and nutrients from the air.
Epipsammic	Attached to sand particles.
Euphotic zone	The surface water layer up to a depth where 1% of the surface illumination still penetrates.
Euryhaline	In marine organisms, indicating the ability to tolerate a wide range of salinities.
Eutrophication	Excessive algal or plant growth caused by high nutrient concentrations.

GLOSSARY OF TERMS continued on next page

Glossary**GLOSSARY OF TERMS** *continued...*

External behaviour response	An external, as apposed to physiological response, to changes in water quality such as abnormalities in migration patterns, movement or swimming speed.
Facultative	Having the ability to live under different conditions.
Filter feeder	An organism that uses complex filtering mechanisms to trap food particles suspended in water, e.g. mussels and oysters.
Fitness for use	The suitability of the quality of water for one of the following five recognised uses: domestic use, agricultural (mariculture) use, industrial use, recreational use and water for the natural environment.
Flora	Plant life characterising a specific geographic region or environment.
Fauna	Animal life characterising a specific geographic region or environment.
Fecundity	The number of eggs produced by an individual or species.
Gas chromatography	A separation technique whereby a sample is distributed between two phases. One of these is a stationary bed of large surface area, and the other a gas (carrier gas) which percolates through the stationary phase.
Gastropod	(Gastropoda) A large morphologically diverse class of the phylum Mollusca, comprising, for example, the limpets and abalone.
Geotactic	Locomotion response to gravity.
Gram-positive	Refers to bacteria which hold the colour of the primary stain when treated with Gram's stain.
Gravid	Pertaining to a female animal when carrying young or eggs.
Grazers	Animals which feed of larger plant material, e.g. algae and kelp, such as abalone.
Herbivore	An animal that eats only vegetation or plant material.
Heterotrophic	Obtain nourishment from the ingestion and breakdown of organic matter.
High performance liquid chromatography	A separation technique in which the sample is introduced into a system of two phases. Differences in the distribution shown by the solutes cause them to travel at different speeds in the system. The mobile phase is a liquid.
Hydride generation cold-vapour method	A method where a volatile hydride is formed and decomposed thermally to enable measurement by atomic absorption.
Hydroid	(Hydrioda) An order of coelenterates, including colonial forms, with well developed polyp stages.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS *continued...*

Hydrolysis	Decomposition or alteration of a chemical substance in water.
Hyper-	Excessive, exceeding, above, over.
Hypo-	Low, under, below.
Hypoxia	Lack of sufficient oxygen.
Humic substances	A general category of naturally occurring, biogenic, heterogeneous organic substances that can be characterised as being yellow to black in colour, of high molecular weight, and refractory. There are three major fractions of humic substances, i.e. humin (not soluble in water at any pH), humic acid (not soluble in water under acidic conditions, pH below 2, but becomes soluble at greater pH) and fulvic acid (soluble in water under all pH conditions).
Iodometric titration	Titration performed with a standard solution of iodine.
Industrial uses	For the purpose of these documents, industrial use of seawater means 'water that is taken from the sea to be used in industrial processes or to be processed for a particular use outside the sea'. Industrial uses of seawater therefore include: <ul style="list-style-type: none">- seafood processing;- salt production;- desalination;- water supply to commercial aquariums/oceanariums;- harbours/ports (excluding recreational use, mariculture practices, natural environment - these will be addressed elsewhere);- cooling water;- ballast water;- coastal mining;- make-up water for marine outfalls;- exploration drilling;- scaling and scrubbing.
Infratidal	(Subtidal) Defined as the zone seaward from the spring-tide low-water mark to a water depth of about 10-20 m.
<i>In situ</i>	In the original location.
Intertidal	The zone between the spring-tide low-water and spring-tide high-water mark.
Invertebrate	An animal lacking a backbone and internal skeleton.
Ionic strength	A measure of the average electrostatic interactions among ions in an electrolyte.
Isopod	(Isopoda) An order of crustaceans characterised by a cephalon bearing one pair of maxillipods in addition to the antennae, mandibles and maxillae.

GLOSSARY OF TERMS continued on next page

Glossary**GLOSSARY OF TERMS** *continued...*

Lachrymal fluid	Tear-like fluid.
LC₅₀	Lethal concentration which brings about a 50 % mortality in an experimental population exposed to the substance.
LC₅	Lethal concentration which brings about a 5 % mortality in an experimental population exposed to the substance.
LC₉₅	Lethal concentration which brings about a 95 % mortality in an experimental population exposed to the substance.
LC₁₀₀	Lethal concentration which brings about a 100 % mortality in an experimental population exposed to the substance.
LD₅₀	Lethal dose which brings about a 50 % mortality in an experimental population exposed to the substance.
Longshore drift	Movement of materials by currents, caused by waves, that set parallel to the shore; usually within the nearshore region in the breaker zone.
Limpet	Several species of gastropod molluscs which have a conical and tent-like shell with ridges extending from the apex to the border.
Lipophylic	Refers to a substance that is soluble in a lipid.
Littorina zone	The highest zone on rocky shores with only a few species of plant and animal life. The tiny gastropod <i>Littorina</i> is very abundant.
Macrophytes	Refers to macroscopic forms of aquatic plants and includes of algae and aquatic vascular plants.
Mariculture	For the purpose of these documents, the mariculture use includes the official mariculture practices along the South African coast (including future possibilities): <ul style="list-style-type: none"> - seaweed; - molluscs - bivalves; - molluscs - gastropods; - crustaceans; - finfish.
Mesozooplankton	Organisms which take the of animal plankton for part of their life cycle.
mg l⁻¹	Milligrams per litre.
mm TL	Millimetres total length.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS *continued...*

Monocyclic	Refers to a molecule that contains one closed ring.
Motor activity	Locomotion.
Natural environment	For the purpose of these documents, the word Natural Environment is used as the collective word to describe the natural plant and animal life of the sea, subdivided into three trophic levels: <ul style="list-style-type: none">- primary producers;- primary consumers;- secondary consumers.
Nematode	A segmented worm.
Neritic	Refers to the region of shallow water adjoining the coast, extending from the low-water mark to a depth of about 200 m.
Norm	Yardsticks by which changes in water quality can be measured.
NTU	Nepheloretic turbidity units in which the turbidity of water is measured.
Nudibranches	(Nudibranchia) Molluscs lacking a shell and a mantle cavity, while the gills vary in size and shape.
Nutrient type distribution	Refer to the distribution of a chemical constituent in the sea. This distribution exhibits surface depletion and bottom enrichment as a result of the involvement of the constituent in biogeochemical cycles.
Offshore drift	Movement of materials by currents flowing away from the shore.
Oligochaete	(Oligochaeta) A class of the phylum Annelida, including worms that exhibit both external and internal segmentation and setae which are not borne on parapodia.
Omnivorous	Eating both animals and plant material.
Oocytes	Eggs before the completion of maturation.
Opisthobranches	(Opisthobranchia) A subclass of to the class Gastropoda containing the sea hares, sea butterflies and sea slugs, generally characterised by having gills, a small external or internal shell and two pairs of tentacles.
Optimum range	Most favourable range.
Osmolarity	The molarity of an ideal solution of a undissociated substance that exerts the same osmotic pressure as the solution being considered.
Oviposition	The laying of eggs.

GLOSSARY OF TERMS continued on next page

Glossary**GLOSSARY OF TERMS** *continued...*

Oxic	Sufficient oxygen availability.
Oyster belt	A zone found on rocky shores along the east coast of South Africa between the Littorina and upper Balanoid zones.
Ozonation	Disinfection using ozone, an oxidising agent.
Palaeartic	Refers to animals migrating from the Arctic regions.
Pluteus	A free-swimming larvae of sea urchins and brittle stars.
Paralytic shellfish toxin	Algal toxin which may cause neurological effects.
Pathogen	(Pathogenic) Causing disease.
Pelagic	Living in the water column in contrast to living on the bottom of a water body.
Peptides	A compound of two or more amino acids joined by a peptide bond.
Phosphatisation	Forming a phosphate coating on a metal.
Phospholipids	Any of a class of esters of phosphoric acid containing one or two molecules of fatty acids, an alcohol and a nitrogenous base.
Phospho-nucleotides	Components of DNA.
Photodegeneration	Degradation by light e.g. ultraviolet light.
Photolysis	The use of radiant energy to produce chemical energy.
Photometrically	(Photometry) The calculation and measurement of quantities describing light, such as luminous intensity, sometimes taken to include measurement of near-infrared and near-ultraviolet radiation as well as visible light.
Photic zone	see Euphotic zone.
Phytoplankton	Planktonic plant life.
Plasm cortisol	A specific cell body.
Piscivorous	Feeding on fish.
Polychaete	(Polychaeta) The largest class of the phylum Annelida, distinguished by paired, fleshy appendages (parapodia) provided with setae on most segments.
Polycyclic	Refers to a molecule that contains two or more closed rings.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS *continued...*

Pre-ENSO	Before El Nino southern oscillation.
Primary producer	Defined as those organisms that synthesise complex organic substances using simple inorganic substances and sunlight.
Primary consumer	Defined as those organisms that primarily live off plants.
Problems	For the purpose of these documents, problems specifically refer to 'problems encountered by a particular use or user of marine water which are caused by a particular water quality property or constituent'.
Proteinaceous	Pertaining to a substance having a protein base.
Proteolytic	Catalysing the breakdown of protein, usually by enzymes.
Protozoa	A diverse phylum of eukaryotic micro-organisms; the structure varies from a simple uninucleate protoplast to colonial forms . The body is either naked or covered by a cyst. Locomotion is by means of pseudopodia or cilia or flagella.
Putrescence	Rot.
Pyrolytic	Decomposition of a substance by applying heat.
Raphe-bearing valves	A slit-like line in diatom valves.
Recreational use	For the purpose of this document, recreational use is water that is used for: <ul style="list-style-type: none">- full and intermediate contact recreation (swimming, water skiing, windsurfing);- non-contact recreation (boating, fishing, bird watching, etc.)
Respiratory pore axis	The axis on which the respiratory pores are situated, e.g. in abalone.
Salinity	Refers to the salt content of soil or water.
Scaling	The formation of dense coating of predominantly inorganic material formed from the precipitation of water soluble constituents.
Seasonality	Refers to changes associated with the four seasons of the year.
Secchi disc	An opaque white disk used to measure the transparency or clarity of seawater by lowering the disk into the water vertically and noting the greatest depth at which it can be visually detected.
Secondary consumer	Defined as those organisms primarily living off other animals.
Senescent algal cells	(Senescence) The study of biological changes related to ageing.

GLOSSARY OF TERMS continued on next page

Glossary**GLOSSARY OF TERMS** *continued...*

Seston	Minute living organisms and particles of non-living matter which float in water and contribute to turbidity.
Site specific	Refers to conditions that are unique or specific to a certain site or location.
Solubility product	A constant defining the equilibria between solids and their respective ions in solution.
Spectrophotometry	A procedure to measure photometrically the wavelength range of radiant energy absorbed by a sample under analysis. It can be visible light, ultraviolet light or x-rays.
Spermatozoa	A mature male germ cell, also known as sperm.
Sporophyte	An individual of the spore-bearing generation in plants exhibiting alternation of generation.
Static bioassay	A bioassay where the test organisms are placed into a tank which contains substances at fixed concentrations.
Stenohaline	In marine organisms, indicating the ability to tolerate a narrow range of salinities.
Stripping voltammetry	Technique whereby the concentration and speciation of trace metals can be determined using a hanging mercury drop electrode.
Sublethal	The concentration or dose of a toxic substance below the threshold which causes death.
Substrata	The substrate on which a plant grows or to which an organism is attached.
Subtidal	Refer to <i>Infratidal</i> .
Supersaturation	Refers to a solution containing more solute than equilibrium conditions will allow.
Surf zone	The area between the landward limit of wave up-rush and the furthest seaward breaker.
Thermocline	A temperature gradient as in a layer of seawater in which the temperature decrease with depth is greater than that of the overlying and underlying water.
Threshold concentration	The highest concentration of a water quality constituent that can be tolerated before damage is done to the organism or process.
Terrigenous	Derived from land.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Titrimetrically	A technique where the substance to be determined is allowed to react with an appropriate reagent added as a standard solution, and the volume of solution needed for complete reaction is determined.
Tolerable range	The extreme values (upper and lower values) that are permitted by the tolerance
Treatability	The ability and extent to which undesirable properties or constituents can be remove or converted from a water body.
Target value/range	The value or range of a water quality property or constituent where there is no known impairment of use, or significant effect on a particular water use. It is this range which describes the desirable water quality and which should be strived for.
Trochophore	A generalised but distinct free-swimming larvae found in several invertebrate groups.
Ubiquitous	Abundantly, common occurrence.
Upwelling	The phenomenon by which deep, colder and nutrient-rich ocean waters are introduced into the well-mixed surface layer.
µg l⁻¹	Micrograms per litre.
US EPA	United States Environmental Protection Agency.
Valency	The number of electrons required to be gained or lost by an atom to reach a state where the outermost electron shell is full.
Veliger	A mollusc larval stage.
Vitellogenin	To produce a protein which is present in the liver, which is then transported into the yolk protein.
Virus	A typical virus consists of nucleic acid (DNA or RNA) neatly rapped in a protective protein coat (capsid). The latter carries a receptor site which will attach to matching receptor sites only on certain cells. This determines the host specificity of viruses.

GLOSSARY OF TERMS continued on next page

Glossary**GLOSSARY OF TERMS** *continued...*

Water quality criteria	<p>(US EPA) A designated concentration of a constituent that, when not exceeded, will protect an organism, an organism community or a prescribed water use or quality with an adequate degree of safety.</p> <p>(Canada) Scientific data evaluated to derive recommended limits for water uses.</p> <p>(Australia) Scientific and technical information used to provide an objective means for judging the quality needed to maintain particular environmental value (water use).</p>
Water quality guideline	<p>(South Africa) A description of the effects of changes in water quality of a water quality constituent on a recognised use in terms of selected norms.</p> <p>(Canada) A numerical concentration or narrative statement recommended to support and maintain designated water use.</p> <p>(Australia) Water quality guidelines translate the criteria into a form that can be used for management purposes</p>
Water quality objective	<p>(Canada) A numerical concentration or narrative statement which has been established to support and maintain a designated water use.</p> <p>(South Africa) A value, not to be exceeded, set for a specific water quality constituent in a defined water body portion or a water body, to ensure with a given measure of reliability, its agreed fitness for use. This is an achievable value determined by considering the water quality requirements of recognised water users as well as relevant physical, technological, economic and sociopolitical issues.</p>
Water quality property/constituent	A chemical (or biological) substance or physical property that describes the quality of a water body. For the purpose of this document water quality refers to water quality constituent, substance or property only.
Water quality standard	(US EPA) A term used in the US EPA literature which is similar to a water quality objective. A standard connotes a legal entity for a particular reach of waterway or for an effluent.
winkle	A gastropod snail.
WHO	World Health Organisation.
Winkler Titration	A titrimetric method for determining the dissolved oxygen concentration in seawater.
Zooanthids	Colonial sea anemones.
Zooplankton	Microscopic animals which move passively in aquatic ecosystems.

APPENDIX D: INDEX

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